# Telephone Engineer

Volume 35 JANUARY, 1931 No. 1

**Coolidge Recommends Advertising** Calvin Coolidge, former president of the United States and present newspaper columnist, neglected problems pertaining to politics and statecraft in a recent column, and delved into the realm of business.

Said Columnist Coolidge:

"It is essential in the first instance to make good merchandise. But that is not enough. It is just as essential to create a desire for it. That is advertising."

Warming to his subject, Coolidge said that the person or association of persons who can produce a combination of excellence and demand is performing a real public service as well as enlarging the mental horizon by providing new forms of utility and beauty.

He concluded with this statement:

"Goods not worth advertising are not worth selling."

These strong statements are of particular interest considering the general state of business at the time they were made. It is safe to assume that that is the exact reason Columnist Coolidge "chose" to consider the subject of advertising at this time. Undoubtedly it has been brought to his attention, as well as to the attention of editors and advertising managers over the country, that business men were prone to meet the depressed business conditions by curtailing their advertising.

It is obvious that the statements penned by Coolidge are not limited in any manner. Notice that he does not say: "When business is flourishing, advertise." Nor does he say: "When business is falling off, advertise." Says he:

"Goods not worth advertising are not worth selling."

**Introducing the Technical Clearing House** Our resolution for the New Year is "to serve you better" through the columns of TELEPHONE ENGINEER. Believing that we can best serve you when each individual telephone man can have a part in our editorial contents, we proudly introduce to you in this issue, the first issue of TELEPHONE ENGINEER for 1931, a new department, called "The Technical Clearing House," edited by B. C. Burden, transmission engineer, Lincoln Telephone and Telegraph Company. We hope you will read it, like it, and take an active part in it.

You probably recall that this feature was announced last month. You may be among those who have already sent us your questions and problems. In any case, those questions already received have been answered by Mr. Burden, and you will find both a statement of the questions and the answers on "The Technical Clearing House" page. In the event that the problems required an answer too lengthy to be published on this page, or were not of general interest, the technical editor has answered them by letter. This policy will be continued in the future.

It is possible that small problems which have been puzzling you have also bothered others in the industry who have written us already, and thus you will find the answer to your own question in this issue. If it hasn't been answered this month, we urge you to write us so that the matter can be cleared up for you as soon as possible. And as new problems arise from week to week and month to month, as they are bound to do in any business or industry, write us about them and we will do our utmost to assist you.

Let our technical editor take care of the research and experimentation—that is his job.

The first article for a new series on the subject of vacuum tube theory and application, also appears

in this issue. A brief review of the basic vacuum tube theory is given in this first article, to prepare the reader for a full understanding of its practical uses in the telephone industry.

---

**Making Telephone History**

The year 1930, which is now history, took long strides forward in making telephone history. Although it may have been a year in which financial wizards lost step temporarily, it certainly is true that engineering wizardry reached the heights, at least in the realm of telephony.

Countries hitherto cut-off from the rest of the world as far as direct communication was concerned have been brought into touch with lands across the mountains and seas by the long arms of the telephone lines. Passengers on ships and trains have been enabled to converse with friends and business associates in distant cities as they traveled. Television has been successfully accomplished, although it is still too expensive for ordinary commercial use. Radio-telephone circuits have been established where the time and expense of laying telephone cables seemed too great. These combined radio and telephone circuits during 1930 alone, brought a total of 177 different international telephone connections in operation.

From day to day in the daily newspapers and from month to month in the telephone and electrical journals, we have read of this and that extension and improvement in telephony. However, it remained for telephone experts to gather together the loose ends of the year's activities and compile an annual report covering the entire development of world communication in 1930, before the average mind could appreciate the tremendous advance in the telephone field made in the past twelve months. This unbelievably impressive report is published elsewhere in this issue.

Probably the most significant part of this entire report is not, after all, the history of past accomplishments, but that which points directly toward greater and more astounding developments in the future. Thirty years ago telephones were considered perfect, and were adopted for general use in homes and offices.

In the years that have elapsed since then, telephones have increased in number five times, ten times, twenty times, over their number in 1900, depending upon the advancement of the community. And as telephones have been multiplied, they have been perfected and extended far beyond the dreams of the most ambitious telephone men of a quarter of a century ago. The year 1930 was a fitting climax to all that has gone before.

Yet now that practically the entire world is linked with every other part by means of the telephone, is the telephone considered a finished, complete thing? Certainly not. The telephone is like a big city. It is never finished. Advancement, improvement, building, rebuilding—such will be the future of the telephone until we know not what seeming miracles may be achieved.

It is gratifying to note that not only was the telephone first created in the United States, but since the birth of the telephone, American capital and American equipment have made possible its growth in foreign countries as well as at home.

---

**Lack of Harmony in Accounting**

For several years telephone accountants have encountered difficulties in the preparation of annual reports for the Interstate Commerce Commission and the state commission. The wide variation in requirements of the national and state bodies regarding information to be furnished in the report has been the chief contributing cause of the trouble. The confusion aroused by these differences is augmented considerably by the lack of similarity between the various state commissions, both as to classification and requirements. The information demanded in the reports from telephone companies in individual states is largely determined by the state department under which the commission operates.

There is a noticeable lack of agreement between state and national authorities and the corporation auditors as to the information which actually is of importance and should be required in the reports. This problem is heightened by the variance in the forms supplied by both the national and state commissions. After attending conferences where the duties of a corporation accountant are discussed first from the national point of view, then from the angle of one of the states, and then perhaps from the viewpoint of the accountant of a large company, accountants are inclined to feel that they can't follow everyone's advice, and be rather more than perplexed the next time they are faced with the preparation of an annual report.

The solution to this dilemma is, of course, very simple. Let the representatives of the Interstate Commerce Commission and the several state commissions confer for the purpose of adopting a simplified, standardized form for reports. In this era of standardization of corporate methods and practices, public authorities should be willing to cooperate on this one detail, which nevertheless is indicative of the entire operations of the corporation.

# Notable Telephone Developments in 1930

## World Communication During Past Year Has Made Giant Strides Toward Giving All Countries Daily Telephone Service with Each Other, Either by Direct Radio Circuits or Through Land Lines from Radio Terminals

### Telephone, Telegraph, Radio

In the rapid advance of worldwide communications, the year 1930 has been a notable one. In this year populations of the Western Hemisphere, Europe and the Far East have become linked by the radio telephone; passengers on ships at sea talk with an increasing number of the world's telephones; long distance land telephony and the growth in the use of automatic telephones have greatly contributed to ease of spoken communications; the radio telegraph has pushed its contacts to farther frontiers; submarine cables continue to maintain their important place in business and news transmission; while broadcasting, facsimile transmission and television have made important strides.

### Radio Telephony

The connecting of widely separated cities of the world by radio telephony, which was hailed as making such rapid progress during 1929, progressed with even greater momentum in 1930.

Already at the beginning of the year, regular daily telephone service was being operated for 74 different international connections, made possible by radio telephone circuits. These connections were either by direct radio circuits or through land lines from radio terminals. During the year many more new international connections were regularly established than during the preceding three years, 11 by new direct radio circuits, and an additional 92 fed into these circuits by land line connections. It seems possible to say that no year in the history of telephony has seen so great an accomplishment in international importance as has this one. It brings a total of 177 different international telephone connections in operation, made possible by the radio circuits set up.

Three groups of countries connected by radio telephone stand out as of leading importance. The first of those established during the year was that between North and South America, linking the United States, Canada, Cuba and Mexico on one end with Argentina, Chile and Uruguay on the other.

The second is comprised of the three new circuits between Europe and South America. On the European end these three circuits operate from Paris, Berlin, and London to Buenos Aires, feeding into land lines to Chile and Uruguay. At the European end land lines connected sixteen countries into these circuits. These are Austria, Belgium, Czechoslovakia, Danzig, Denmark, Finland, Italy, Hungary, Latvia, Lithuania, Netherlands, Norway, Poland, Sweden and Switzerland. In addition, making seventeen, is Spain, which circuit was set up in 1929.

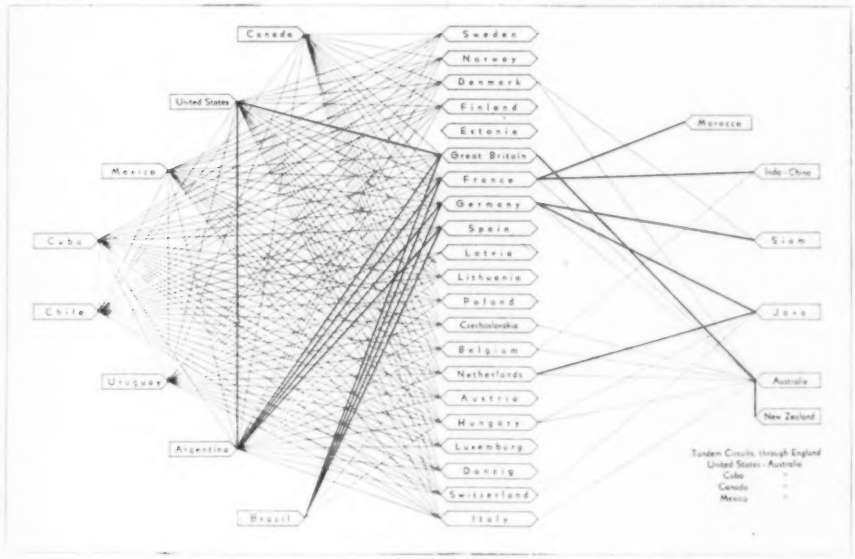
The third of these is the London-Sydney circuit, a distance of 9,192 miles, and its subsequent extension, through London, over the transatlantic circuit to North America. Thus two radio circuits simultaneously operating in tandem with each other and with extended land line systems connect most of the telephone subscribers of the United States, Canada, Cuba, Mexico, Great Britain, Hungary, and Italy, with Australia. Australia has also connected with New Zealand, which will soon become part of this network.

Other new direct circuits opened during the year were between Rio de Janiero and Paris, Berlin and Madrid, Berlin and Java, Paris and Morocco, and Australia and New Zealand, with several other European countries tied into these services.

Leading in this development have been the American Telephone & Telegraph Company, International Telephone & Telegraph Corporation, British Post Office, and also the telephone administrations of France, Germany and Australia.

As a sum total the criss-cross of sweeping lines across the world map of radio telephony presents nothing less than a marvel of instantaneous exchange of the spoken word for whoever among 90 per cent of the world's telephone users may lift the receiver of his own telephone.

In the meantime much pioneer construction of new stations and new laboratory experiments and tests are proceeding to establish still more circuits. Those under construction are for additional South American connections from Brazil, Chile, Peru and Colombia, to the United States and Europe; between the United States and Hawaii; and others projected are between United States and Japan, Philippines and Australia, and British Empire connections with Canada, India, and South Africa, as well as with Japan and China. Tests were undertaken during the year between Buenos Aires and Sydney, London and Java, and New Zealand; Buenos Aires and Java via Berlin, and many others. Particularly of interest was a conversation sent around the world from Schenectady, New York, and then rebroadcast, and conversations carried out by Captain Lewis Yancey in a plane flying over Buenos Aires with points in the United States, with the S. S. "Majestic" on the high seas, and with Sydney, Australia, a distance of more than 14,000 miles.




*International telephone connections available through radio telephone circuits*

### Radio Telephony in Mobile Services

The most substantial advance in mobile radio telephony during 1930 was in services to transatlantic passenger liners. Such telephone service, first opened in

1929 between the S. S. "Leviathan" and the United States, and the S. S. "Majestic" with England, was extended in 1930 to the "Majestic" with the United States, the "Leviathan" with Europe, the "Olympic" and "Homeric" with both sides of the ocean, and widened to connect with twelve other countries: Canada, Cuba, Mexico, Belgium, Germany, Spain, Netherlands, France, Switzerland, Austria, Denmark and Sweden. These services were made possible by cooperation between the International Marine Radio Company, International Telephone & Telegraph Corporation, American Telephone & Telegraph Company, and the British Post Office.

English Channel service was opened with the "Golden Arrow" route, and tests are also being made with several other ships. Interesting applications were of radio telephone to New York harbor fire boats and a system developed by the United States Navy for telephony with submarines, demonstrated by a successful broadcast from beneath the ocean.

In radio telephony from railroad trains commercial service was started in April on the Canadian National Railway's Montreal-Chicago express, opened by conversations with England. This will be extended to the Grand Trunk Railway. The use of radio between the ends of freight trains has been found practicable by the American Railway Association.

At the same time experiments are going on for airplane telephone service along American air routes, considerable equipment having been ordered. The Aeronautics Division of the United States Department of Commerce announces a plan for sending telephone messages along radio beacon channels.

### Long Distance Telephony

The widespread extension of international radio telephone circuits to so many countries, outlined before, could obviously not be possible without efficiently functioning land line circuits to carry the conversations from radio terminals to destination.

Over long distance it is the telephone cable, properly equipped with repeaters and loading coil amplifiers which makes efficient service possible. It has been the substantial program of installation of such cables, as well as the supplementary use of "carrier current" systems in European countries during the past few years that provides the means for carrying international conversations. The first results of these installations had begun materially to show themselves during 1928 and 1929 in the establishment of a widening range of services between European countries themselves. During 1929 and 1930 they became the wire links for transoceanic telephony.

Australia's progress, particularly in use of "carrier current" has also been rapid. In South America, two or three installations have pointed the way to the need and possibility of long distance telephony. Similar installations have been made in Japan and the Federated Malay States and are under way in China, but continental Asia, Africa, and the Near East are yet to achieve any appreciable long distance telephone communication to the extent enjoyed in other continents.

The completion of such major projects in Western European countries in 1929 has been followed by a national telephone installation in Italy, and extensive installations in Eastern Europe and the Balkans during the present year, bringing these countries much more closely into touch by telephone with the rest of the world.

Completion of telephone cable projects in Hungary during 1930 provided the means for telephone connection with Rumania and many cities of Yugoslavia, and through Austria, to many countries in the west of Europe. In this Hungary now forms the link for new transit services from countries to the north and west with Yugoslavia and Rumania. Thus during the year Czechoslovakia opened telephone communication for the first time with Hungary and Yugoslavia; Poland and Lithuania with Hungary; London, Paris, Brussels, and Berlin were connected into the Balkans; Switzerland was linked with Poland, Hungary and Yugoslavia. Great Britain and France extended telephone service to Lithuania, Latvia, and Estonia; and Luxemburg tied in with many European systems. Substantial construction in Czechoslovakia not only helped transit traffic but greatly improved her telephone connections with neighbors, particularly Germany.

Italy's cable system laid largely in 1930 brought the peninsula for the first time into adequate telephone connection with the European networks, and provided means for numerous extensions into Eastern Europe as far as Yugoslavia, and by radio telephone to the rest of the world. The Vatican State, with a new automatic telephone system, likewise obtained telephone connection for the first time with countries outside Italy.

Great Britain laid two new telephone cables across the English Channel. Germany and Sweden were connected by an additional telephone cable and the great increase of traffic recently laid cable between Sweden and Finland led to contracts being placed for a second. The Kerrara Islands, Scotland, were for the first time linked with the mainland.

In China the starting of the laying of the Hong Kong-Canton cable is part of the plans of the Nationalist Government for building up long distance telephony.

In Latin America, Mexico made additional connections with the United States, and Guatemala and El Salvador made their first international telephone connection. Traffic with Cuba necessitated the laying of a fourth telephone cable between Havana and Key West, and the response in traffic of transatlantic telephony continued the preparations for laying of the first transoceanic telephone cable between North America and Europe.

As to the advances of telephony within the United States, which have been substantial, it is a subject for a separate report, best seen in those of the American Telephone and Telegraph Company.

### Television

While television experiments have been continued with much progress during 1930, visual broadcasting has not quite emerged from the laboratory stage. It is described by the American Radio Commission as not "having developed to the point where it has real entertainment value." However, taking a lesson from the history of audible broadcasting it is possible that television will move ahead much more rapidly when regular broadcasts are started.

A particular demonstration in 1930 was the transmission of a television picture from Schenectady to Australia and back. Two way simultaneous telephone and television communication was demonstrated for the first time by the Bell Laboratories, while General Electric engineers transmitted a life size television image to a theatre a mile away. Claims of new inventions are for an apparatus for transmitting television in color, a television receiver that can be attached to an ordinary radio set, and an invention claimed to totally eliminate mechanical scanning in television transmission and reception.

---

## NOW ONLY ONE COMMUNITY WITH TWO SYSTEMS

One of the last two communities in Michigan with two telephone systems will soon have just one consolidated system, according to a report which has reached TELEPHONE ENGINEER.

That community is Eaton County, Mich., where for a number of years the Michigan State Telephone Company and the Eaton County Telephone Company have vied for supremacy in the district. The majority of the stock in the latter company is held by Fred and Floyd Bohn.

Now, however, the two concerns have agreed on a price and the Michigan State Telephone Company will take over the Eaton County Telephone Company, as soon as approval is given by the state public utilities commission.

# Functions of Trunk Circuit Common Relays

**The Last Sixteen Relays of the Straightforward Trunking System Are Here Described by John H. Levis, Jr., Telephone Engineer, Rochester, N. Y., in the Seventh of His Series of Articles**

The following paragraphs describe the functions of the last sixteen relays of the common portion of the straightforward trunk circuit. The functions of the A, B, C and D relays of the commons are also described.

In the study of the functions of the common relays, reference should be again made to the circuit diagram of the complete straightforward "B" trunk circuit which was published in the October, 1930, issue of TELEPHONE ENGINEER.

The diagram of relay symbols accompanying this installment shows the last sixteen relays in the common circuits and gives them their position in the circuit according to number location and also shows their respective direct current resistance values. The relays are also shown in the same position as they are placed in the diagram of the complete circuit. This enables the reader to determine the resistance of the windings involved in the various wiring connections.

All relays that are connected to the star terminals, other than on the trunk circuit proper, are the common relays to all of the forty trunks in the position. Dash lines represent the common wiring from the common relays to the trunk circuit proper.

In the wiring diagram it will be noted that in a number of places in the common wiring there are a one microfarad condenser and a 500 ohm non-inductive resistance connected in series and placed in such a position to either bridge relay contacts or placed across relay windings. These units are used to absorb the sparking and inductive reactions that appear at the relay contacts. This prolongs the life of the contacts. The reason for the non-inductive resistance in series with the condenser is that when the condenser is normally charged and the contact which it is protecting is closed, the condenser is short-circuited by the contact but through the five hundred ohm resistance, thereby cutting the effective current very low and not causing any damage to the contact. Without the resistance there is a tendency for the contacts to weld together or become badly pitted.

Following is the description of the common relay functions:

19. *Control Relay for Non-Overlap with Plug-in Line When Pre-Selecting*

When a trunk is cut into the common circuit and the number 11 relay operates, this relay will operate from the trunk circuit number 9 relay winding. This relay is 10,000 ohms resistance and number 9 will not operate through it. It furnishes a multiple path around the break contacts of relay number 31 so that when any ringing selecting key is operated and number 31 operates, the releasing of the trunk is not possible, but, in which case, the pre-selection of the ringing is set. The trunk operator is still in on the trunk.

**CONVENTION SCHEDULE**

**Minnesota Telephone Association, Hotel Lowry, St. Paul, January 27, 28 and 29.**

**Nebraska Telephone Association, Lincoln Hotel, Lincoln, February 10, 11 and 12.**

**Northern White Cedar Association, Minneapolis, Minn., February 10 and 11, Hotel Radisson.**

**Oklahoma Utilities Association, Oklahoma City, Okla., March 10, 11, 12, Huckins Hotel.**

**Texas Independent Telephone Association, Forth Worth, Texas Hotel, March 17, 18, 19, 1931.**

**Iowa Independent Telephone Association, Hotel Fort Des Moines, Des Moines, April 7, 8 and 9.**

**Indiana Telephone Association, Indianapolis, May 6 and 7, Claypool Hotel.**

**Up-State Telephone Association, Rochester, N. Y., May 20, 21, Seneca Hotel.**

**Pennsylvania State Telephone & Traffic Association, Hotel Penn Harris, Harrisburg, May 26, 27 and 28.**

**Kansas Telephone Association, Abilene, June 2, 3, 4, The Sunflower Hotel.**

Should the non-ringing key be operated, the above does not hold true, as the number 19 relay will be short circuited, which provides a zero resistance ground to the number 9 relay. The trunk will be released from the common equipment the same as though the plug was out of the line jack. This is so arranged that, should a trunk show a cut-in when the stations are talking, all that is necessary on the part of the trunk operator is to operate the non-ringing key and pass to another trunk circuit.

This relay also closes a circuit for the operation of the number 20 relay.

20. *Time Element Relay for Releasing Trunk When Plug Is Withdrawn from the Line After Pre-Selection of Ringing*

When a ringing key is operated, the number 20 slow releasing relay operates and locks up from its own contacts and winding through the number 19 relay which is operated.

This combination remains in this position after the ringing key is released. The number 31 relay also remains operated from the number 20 relay, placing the circuit in a releasing condition. As soon as the plug is withdrawn from the line jack, the number 9 relay of the trunk operates, releasing all of the relays involved in the cutting out of a trunk. The operation of the number 9 trunk relay under the above conditions is accomplished by the way of a second operating path or circuit through a contact of the number 11 trunk relay. The number 11 relay is held operated from the number 8 trunk relay which is in a line jack.

When the plug is withdrawn from the jack, the numbers 8 and 11 relays release, closing the operating path to the number 9 trunk relay through the number 5 relay through the splitting relay number 11 in the common circuit to the ground contact of the number 20 slow releasing relay, operating the number 9 relay in the trunk. This releases all the relays involved in the trunk circuit proper and all the common relays. All of the common relays are then prepared to accept a new trunk call.

21. *Advance Traffic Relay*

As trunks are taken at the "A" office end of the terminating trunks in advance of the circuit that is cut in to the trunk operator, the trunk lamps will not be lighted because they appear as a steady light and are at times confused with disconnect signals which are also a steady signal and the locations of the plugs are not always possible on account of the congested cord mat that may exist during a rush period; therefore, no lamps will be lighted unless the advance traffic key (common to 20 trunks) is operated and places the number 21 relay which is low in ohmic resistance across the number 34 relay which is high ohmic resistance, causing all advance trunk signals to light.

This same feature of advance traffic key operation is used when the trunk position is operated on an emergency cut-in key basis, as it is then necessary to determine the location of the calls as they will not be cut-in automatically.

In the circuit shown in the October, 1930, issue of TELEPHONE ENGINEER, a connection was omitted. It is from the

first contact to the right of the number 11 common relay winding. It should be connected to the wire or line directly above the contact. Please make the change on the circuit diagram. The slow releasing relay marked number 30 should be number 20.

Supervising operators at times operate the advance traffic key to determine the number of unanswered incoming calls in a position and if this number is larger than average, the trunk operator is speeded up or possibly another "B" position is occupied to relieve the congestion.

The number 34 relay is normally in the lamp common circuit, one for every 20 trunks and two per position of 40 trunks. Relay number 21 and number 34 close contact circuits that operate the position pilot relay number 26.

*22. Call Passing Tone Control Relay*

This relay operates from the number 9 common relay each time a trunk is answered automatically by the trunk operator or key cut-in. It closes both the primary of the tone repeating coil to operators' talking commons and the secondary of the same coil to the source of tone from power tone leads to the two pulse tone control relays numbers 23-24-25. "B" operators' outgoing office lamp indication circuits are also controlled on this relay. They are not shown in the diagram. On relay number 22 it is marked "B" operator's control.

*23. First Pulse of Call Passing Tone Control Relay*

This relay is slow to operate and retains the tone on the circuit slightly longer than an ordinary type of relay. At the time relay number 22 operates, the operating path for number 23 relay is closed from the ground on the number 10 relay and the first pulse of the tone is sent out to the trunk circuit via the operator's talking commons. The number 23 relay is non-operated and the tone lead to the secondary of the repeating coil is opened and the tone is stopped, giving the first tone impulse. The same operating lead that operates this relay is extended to the number 24 slow operate relay. The number 23 relay remains operated.

*24. Second Pulse of Call Passing Tone Control Relay*

This relay is also of the slow to operate type. When it operates, the tone is again sent out to the trunk in the same manner as described under the number 23 relay. The tone lead is closed by a contact of this relay through the operated number 23 relay. This relay also closes an operating path for the slow operating relay number 25.

*25. Operator's Cut-in and Tone Cut-off Control Relay*

This relay is also of the slow to operate type. When it operates, the tone lead is opened, completing the two pulse call passing tones and it also closes the operating path for the operation of the operator's cut-in relay number 10. When relay number 10 operates, relays numbers 23, 24 and 25 all release, allowing them to be in a positioin for the next trunk circuit cut-in.

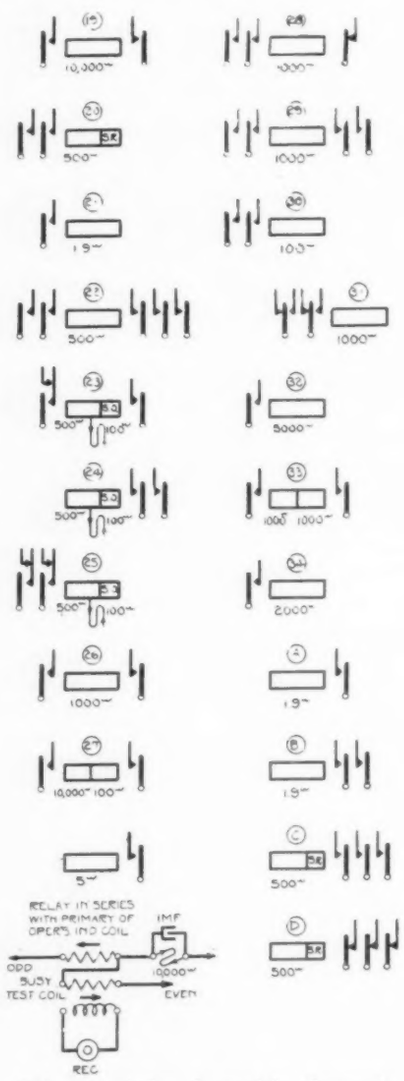
*26. Pilot and Night Alarm Control Relay*

This relay operates from either the number 21 or number 34 relays and closes a circuit for both the pilot lamp and night alarm circuit. All incoming calls operate this relay.

There are two pilots per position, one for the 1 to 20 trunks and the other for the 21 to 40 trunks. There are two number 26 relays per position.

*27. Common Master Key Splitting Control Relay*

At the time a trunk is cut-in, this relay operates on its high resistance winding of 10,00 ohms through operated number 29 relay to the number 5 relay in the trunk circuit to the number 7 relay in the trunk. Relay number 7 does not operate at this time. With the number 27 relay operated, the number 11 relay




*Relay symbols of straight forward trunk circuit common relays and their direct current resistance values.*

masted key splitting relay operates, cutting the common key circuits to the trunk that is cut-in. It also closes a path for the operation of the number 9 relay which starts the call passing tone. The number 9 relay also furnishes a second guard circuit to the number 11 relay. The circuit for operation of the number 9 relay comes from the operated number 28 relay. The low resistance winding of the number 27 is connected to the master ringing control relays through the number 11 relay.

When any ringing key is operated, a ground circuit is furnished from the master relays through the number 11 relay and the low resistance winding of the number 27 relay through the number 29 relay to the numbers 5 and 7 relays of the trunk, which is the ringing control relay of the trunk and which, in this case, operates and sets the ringing for the trunk. The number 27 relay holds up during this procedure on its high winding until No. 5 of the trunk releases. This is done so that the proper time element in the holding of the number 11 relay is assured and so that it will not be released until the trunk circuit just pre-selected is free from the common equipment. This eliminates any possibility of a second or premature preselection at the time of a legitimate preselection.

*28-29. "B" Operator's Local Control Circuits*

The relay above the number 28, which is wired in series with the primary of the operator's induction coil and transmitter, operates when a "B" position is occupied. It is of a low ohmic resistance type. It closes a circuit for the operation of the numbers 28 and 29 relays. The number 14 relay circuit is closed, also ground to the number 27 and the night alarm is opened from the number 26 relay. When a position is occupied, it is not necessary to have a night alarm, as the circuits are cut-in automatically to the operator.

The number 29 relay closes the odd and even busy test leads to the tips of the trunk plugs through the number 11 relay of the trunk circuits. The busy test repeating coil is arranged so that all even numbered trunk busy test commons are connected to one coil of the repeating coil and all the odd busy test commons are connected in a reverse manner to the other coil. This is done so that no inductive disturbances will be heard in the "B" operator's head set as the tertiary coil or winding is connected across the operator's head set or receiver. This is necessary because there are 40 trunks in a position and the cable conductors from the relays to the positions where the cords and plugs are located are very long and the circuit of the test commons are unbalanced because the connection is only on one side of the

trunk circuit, all giving rise to possible noises. This type of neutral or differential coil connection eliminates the inductive disturbances. It will be noted that a one microfarad condenser in shunt with a non-inductive coil is shown connected to the busy test windings of the repeating coil. This resistance is 10,000 ohms and is necessary because when a "B" position is being operated, the plugs are constantly coming in contact with one another and, as the number 8 or sleeve relay of the trunk circuit should be operated only when in a line jack, it is possible to prematurely operate it, should the tip of a trunk come in contact with a sleeve conductor and if the resistance in the busy test commons is too low in ohmic resistance.

The condenser across the resistance is to augment the click to the operator as the direct current circuit while taking a busy test is very low, due to the high resistance. The circuit for the reverting busy tone control circuit is also closed through the number 29 relay. The circuit to relay number 27 to the trunk circuit is also closed.

With the exception of the night alarm circuit on the number 28 relay, all of the above controls are opened when a "B" position is not occupied. This is caused by the grouping of the "B" positions. Otherwise, common circuit interference would result.

30. *Cut-in Key Common Relay*

This relay was described under the operation of relay number 16 common circuit.

31. *Time Element Control Relay for Trunk Circuit Cut in Relay Number* 10

When any ringing key is operated, this relay operates and opens the path of number 13 relay to the trunk circuit number 10 relay. This path is by-passed by the operation of the number 19 relay and it gives a time constant in the cutting-in of another trunk after the number 19 releases.

32-33. *Reverting Busy Tone Relays*

These relays are arranged on the basis of one set for every twenty trunks. This is done so that if only one set per position is used and trouble develops, the entire position will not be disabled.

When a reverting busy tone key is operated, the number 12 relay in the trunk circuit operates and closes a circuit from the battery coil of trunk relay number 2 through the repeating coil to the number 32 relay of 5,000 ohms resistance. The number 2 relay will not operate but the number 32 relay operates, placing the common grounded 120 I. P. M. busy tone interrupter to the number 33 busy tone control relay, which places the busy tone to the tip of the trunk repeating coil and to the ring side of same coil. The result will be the well known buzz, buzz effect. The condensers in series with the busy tone leads are used as the tone machine is of the inductor type and its output tone windings are not connected directly to battery or ground. These condensers maintain the above condition as well as preventing the number 2 trunk relay from operating while connected to the busy tone circuit.

The winding or relay number 32 should be removed from tip lead as shown and placed on the lead going to the number 12 relay of the trunk circuit.

The method used in the combination of relay numbers 32 and 33 eliminates the continuous operation of the number 33 relay, except when actually required by a trunk circuit.

34. *Advance Traffic High Resistance Relay*

This relay is 2,000 ohms resistance and is fully described under relay number 21 description.

A-B-C-D. *Trunk Lamp Flash Control Relays*

At the time of an actual operator cut-in on a trunk circuit, the number 10 relay is operated and closes a path for the trunk lamp through the contacts of the "D" relay through the "A" and "B" relays. Both the "A" and "B" relays operate in series. The "A" closes a path to the night alarm circuit if the position is unoccupied, as in the case of relay number 26. The "B" relay operates the "C" relay which in turn operates the "D" relay, opening the operating path to the trunklamp which causes the lamp to be extinguished. Relays "A" and "B" release quickly and the "C" and "D" release progressively in a slow release manner. The final release of "D" relay causes the trunk lamp to re-light. The above condition will continue as long as the trunk operator is cut-in on a trunk circuit. The rate of the relay cycle is 240 operations per minute or 240 trunk lamp flashes per minute.

The resistance of the "A" and "B" relays are 1.9 ohms each and are of the low ohmic resistance type, in order that the trunklamp will light through them. The "C" and "D" relays are of the slow release type so that the rate of flashes per minlte can be controlled from the standpoint of adjustment. The contacts of these relays are protected with condensers and resistances.

Each trunk position is equipped with two sets of flash relays, one set with the 1-20 trunks and the other with the 21-40 trunks.

The flash relay circuits operate only when the operator is cut-in on a trunk. This reduces the mechanical wear of the contacts, as there are periods of light traffic and when positions are unoccupied.

Another advantage of positional flashing circuits is that, under the older methods of common flash interrupter per "B" switchboard, a case of trouble occurs in the common, causing all fish circuits to be out of order.

## TELEPHONE AIDS RESCUE WORK

A telephone located in the mine of the Creek Coal Company in Millfield, Ohio, first informed the world of a violent explosion within the mine which subsequently dealt death and destruction to the mine itself and 82 persons pinned beneath the wreckage.

The message of the disaster, relayed from the private line through the Chauncey exchange of the Athens Home Telephone Company and thence to Athens was a signal for the beginning of the busiest days in the history of the Athens telephone company. Operators responded to the need and handled five times as many local and long distance calls as normally answered requirements and in addition got in touch with every availble doctor and nurse and sent them to the rescue of the imprisoned men, who were being suffocated by gas within the mine.

When the rescue work was under way the executives of the Ohio Bell Telephone Company took it upon themselves to install a special telephone line to the mine, to answer the needs of newspaper men and rescue workers whose work was hampered by the fact that it was necessary to traverse the mile and a quarter into Millfield to use the telephone.

This special line was laid along the ground between Millfield and the mine, over logs and tree branches, along fences, and everywhere that it could be placed without endangering the wires, and was completed with telephones in use at the end of three hours of strenuous work. At Millfield the line was connected with the Athens-Glouster line, which is operated jointly by the Athens and Glouster companies.

## CEDARMEN TO MEET FEB. 10TH AND 11TH

Announcement has been made that the thirty-fifth annual meeting of the Northern White Cedar Association will be held on Tuesday and Wednesday, February 10th and 11th, at the Hotel Radisson, Minneapolis, Minn. Heretofore meetings have been held during the month of January.

## STOCKHOLDERS RECEIVE REGULAR DIVIDENDS

Directors of the United Telephone Company, Cleveland, Ohio, declared the regular cash dividend of $1.75 per share on the first preferred stock $7 dividend series. The dividend was payable January 1, 1931, to the stockholders of record of December 20, 1930.

# Full Description of Type C Carrier System

**This System Especially Adapted to Long Distance According to F. J. Dommerque, Fellow A. I. E. E., Who Here Presents the Fourth of His Series of Articles; Type C System Accommodates Three Carrier Channels in Addition to Voice Current Channel.**

It was stated before that the type C carrier system came into use before the type D. It accommodates three carrier channels in addition to the regular voice current channel, while type D system provides only one additional carrier channel, but both systems are carrier-suppressed, single sideband systems. As the allocation of frequencies is an important matter and differs in the two systems, we will take this matter up first, using for our discussion an enlargement of Fig. 1 in the paper on "Carrier Telephone Systems for Short Toll Circuits" in the July, 1929 TELEPHONE ENGINEER, which shows the frequency allocation for both, the type C and D system, in one diagram.

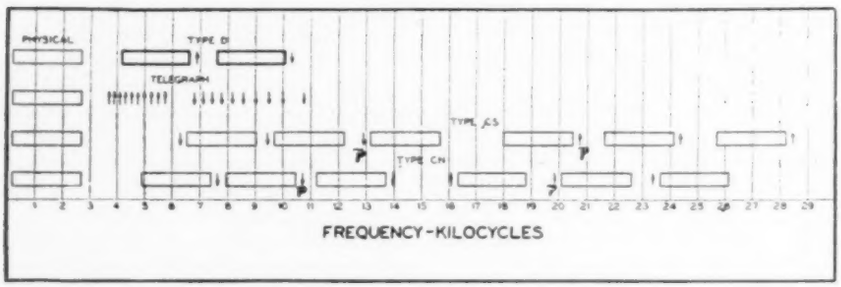



*Fig. 1.—Frequency allocation of type C & D system*

In the upper row of the diagram appears the frequency allocation for the type D system, showing first the physical, that is, the voice current range from about 250 to 2,600 cycles; then the lower side-band of a carrier of 6,267 cycles for transmission in one direction, and next the lower sideband of a carrier of 10,300 cycles for transmission in the opposite direction. This arrangement permits the type D system to be used on the same poles with certain type C systems and carrier telegraph systems.

In the row below the frequencies for type D system are located the frequencies assigned to the telegraph, which does not interest us for the present.

In all rows the arrows indicate the exact location of the carrier frequencies and also the direction of transmission.

In the following two rows are shown the frequencies for two type C systems. As will be noticed the frequencies in the two rows are staggered which produces a reduction of crosstalk; to distinguish between the two frequency allocations, the upper one of the two rows has been designated as the S frequency allocation and the lower one as the N frequency allocation, and correspondingly we have a type C-S system and a type C-N system. Whenever two adjacent pairs of wires on a pole line are used for a type C carrier system, it is the best policy to use type C-N on one pair and type C-S on the other pair, and whenever four pairs are used on one 10-point crossarm, to use the two wires next to the pole for one side of a phantom circuit and the two corresponding wires on the crossarm below or above as the other side of the phantom, leaving four pairs for the carriers, the pairs on each side of the phantom using the C-N and C-S system.

The type C carrier system is adapted for long distance service over practically any distance by placing repeaters in the line spaced at intervals of 150 to 300 miles.

Fig. 2 gives the arrangement of a complete type C carrier system.

There will be no necessity of describing the system in detail, as all the constituents have been described in the previous papers on carrier currents. The three carrier channels 1, 2 and 3 terminate at the sending and receiving stations, also the voice frequency circuit 4. Only one intermediate repeater is shown, there may be any number of them, all of which will be the same. The line filters pass voice frequencies only while the high-pass filters H. P. pass only the carrier frequencies. Taking the carrier channel 1 as an example, the voice currents

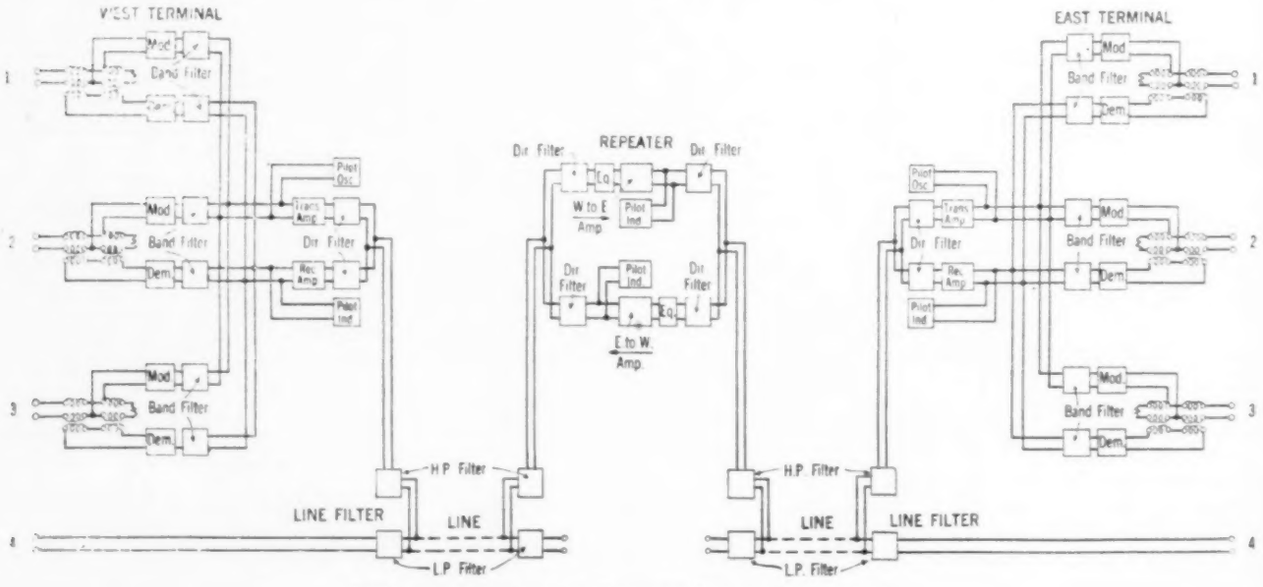



FIG. 2—A COMPLETE CARRIER SYSTEM SCHEMATIC

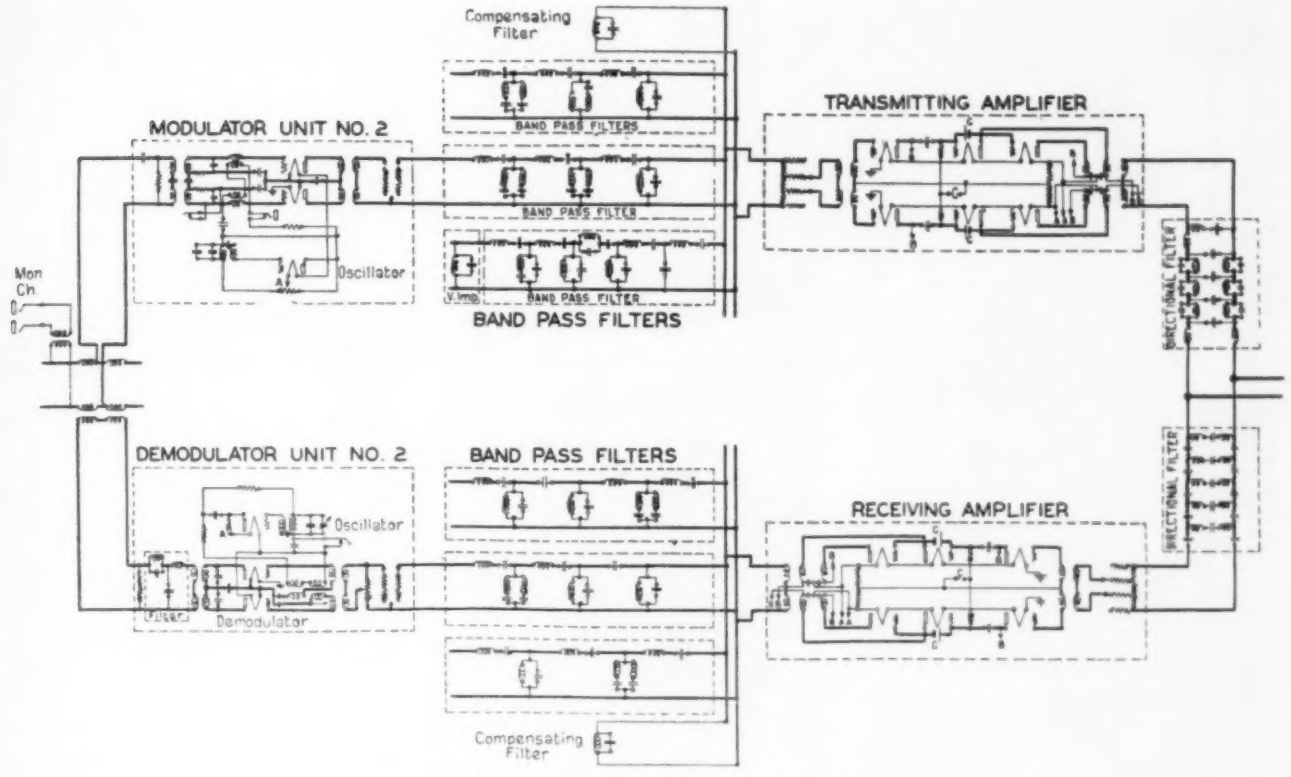



*Fig. 3. Diagram of type C terminal circuit*

coming from the long distance board pass over the three-winding hybrid coil with its balancing network into the modulator, which receives from an oscillator (not shown in Fig. 2) the required high frequency to be modulated. The modulated frequency band then is freed from all frequency bands except the desired band in the band filter; the desired band passes thence through the transmitting amplifier and through a directional filter. which distinguishes between the frequency band coming from carrier channel 1 meets the modulated frequency bands of similar description coming from the carrier channels 2 and 3; consequently the transmitting amplifier and the directional filter serve all carrier channels in common.

The sending and receiving station equipment is shown in more detail in Fig. 3. There is very little difference between sending and receiving station. We see that the demodulator unit contains a low-pass filter, wherein the undesirable components of demodulation are suppressed.

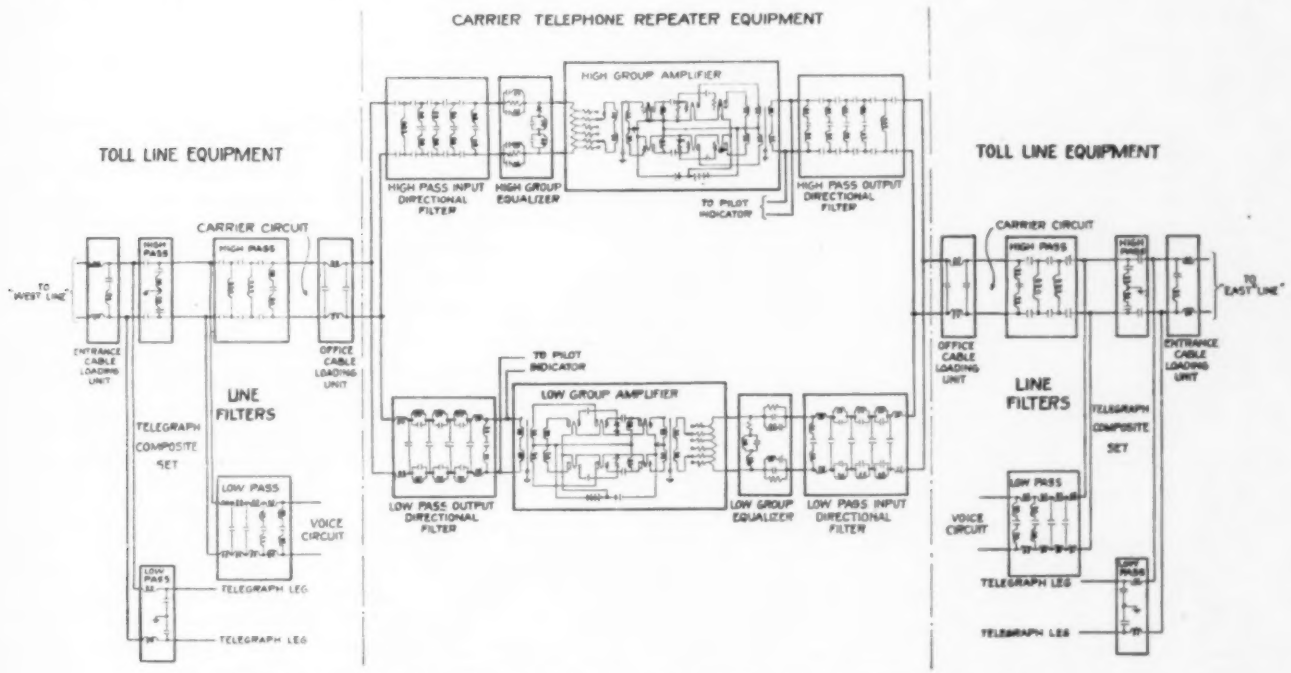



*Fig. 4 General schematic of carrier repeater circuit with associated line equipment*

Returning again to Fig. 2, a schematic of the repeater is shown connected into the carrier line. In addition a more de-

tailed circuit of the repeater with its associated line equipment is presented in Fig. 4. This repeater is practically the same as used on voice current frequency lines.

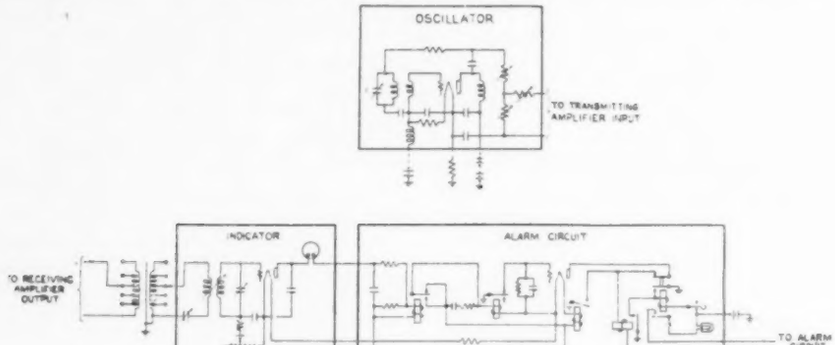



*Fig. 5. Schematic of pilot channel circuits. (The alarm circuit is used with terminals only.)*

From Fig. 4 it will be learned that reference is made to an entrance cable loading unit. As a rule a long-distance circuit is brought into the repeater station in a cable, even when the circuit itself is an open wire circuit outside the exchange. As long-distance lines are mostly used for composite work, two low-pass filters have to be provided, one to pass the telegraph currents and another one to pass the voice frequency currents, and two high-pass filters to transmit the carrier frequencies. Behind the high-pass input directional filter an equalizer is inserted, which has to balance the attenuation-unbalance caused by the variation in attenuation with increase in frequency. The equalizer is composed of a network, which produces a transmission loss, which is lowest at the highest frequency of transmission and increases with decreasing frequency, whereby the over-all repeater amplification becomes a function of the frequency; that is, proportional to the line attenuation, which it has to overcome.

It remains to give some explanation of the pilot indicator mentioned previously.

We deal here with open wire circuits of great length, which are frequently exposed to severe weather. In rain or snow storms the attenuation is greater than in dry weather. Change in temperature changes the resistance, and moisture or humidity the leakage, all of which affect the attenuation, which must be kept low by regulating the losses. How far one is to go in making gain adjustments is ascertained by means of a separate pilot channel, which indicates upon a milliammeter the transmission level. This meter is adjusted for the normal attenuation, and when a deviation is shown upon it, a corresponding correction must be made by means of a potentiometer provided at the terminal station or at the intermediate repeater station. The pilot channel circuit is given in Fig. 5. The pilot channel is a separate channel with constant frequency, introduced between certain speech channels in each transmission group at points marked by P in the frequency allocation diagram Fig. 1.

The indicators with their meters are bridged across the output of the amplifiers at the intermediate repeater stations and also at the receiving stations. The oscillator, from which the pilot channel receives current, is connected at the input to the transmitting amplifier at the sending station. Each direction of transmission has its particular pilot frequency, the band of which is kept very narrow; thus only little is cut out off the total frequency range. The pilot current circuit is tuned so as to block all frequencies with exception of the current frequency. The pilot current is amplified in the indicator circuit and rectified in a detector. The direct current so obtained is read on a direct current milliammeter, which is so calibrated as to indicate in transmission units.

Connected with the indicator circuit is an alarm circuit operated from the indicator. It functions only when the transmission level has deviated during a certain time interval from its normal value. This delay is provided to make sure that the deviation in the transmission level indicated by the meter is definite. Ordinarily the magnitude of deviation is so fixed that the alarm operates at a deviation of $\pm$ 1.5 TU.

The illustrations in this paper are reproduced from a paper read by Affel, Demarest and Green at the summer convention of the A. I. E. E. in June, 1929.

## Book Review

*House Wiring*, the seventh revised and enlarged edition by Thomas W. Poppe, electrical engineer. 252 pages, 171 illustrations. Price $1.00.

This valuable, technical book, "House Wiring," has been brought up to date by Harold P. Strand, master electrician contractor, so that it conforms to the rulings of the 1930 code of the National Board of Fire Underwriters.

Complete in every detail, this little book would prove valuable to every electrician and students of electricity, as within its pages can be found information necessary for the successful accomplishment of any job of building wiring.

Plans and the layout of the work in both old and new construction, locating outlets, sizes of wire to use, armored cable wirings, selecting necessary outlet boxes, planning circuits, testing new wiring systems, wiring in concrete construction, wiring garages, meter board construction, and wiring and switch connections, are just a few of the many topics to be found fully discussed within the pages of this book. It is pocket-manual size.

## MINNESOTA TELEPHONE COMPANIES MERGE

Merger of five Minnesota telephone properties with the Pioneer Telephone Company of St. Paul was disclosed recently following filing of articles of incorporation for new corporations to take over the additions.

The new corporations include the Wabasha County Telephone Company, Douglas County Telephone Company, North Star Telephone Company, Swift County Telephone Company and the Empire Telephone Company.

The Pioneer Telephone Company is a holding company controlled by a number of independent telephone utility operators over Minnesota, with headquarters in St. Paul. It now controls properties operating in nearly 25 communities in Minnesota.

## UTILITIES CONVENTION AT OKLAHOMA CITY IN MARCH

Oklahoma City.—The thirteenth annual convention of the Oklahoma Utilities Association will be held at Oklahoma City, March 10, 11 and 12. Attendance is expected to exceed 1,000, including representatives of electric light and power, gas, electric railway, telephone, and electrical and telephone manufacturing and jobbing companies operating in Oklahoma. Leaders of the public utility industry from several states will address the convention and many subjects of vital interest, not only to public utility companies but to their customers, will be presented and discussed, according to E. F. McKay, Oklahoma City, manager of the association.

# To Dial or Not to Dial —That Is the Question

E. R. Stonaker, Consulting Engineer,
Rochester Telephone Corporation
and
Stromberg-Carlson Telephone Manufacturing Company

"To dial or not to dial" is the question which is confronting the managements of many of the approximately 9,000 Independent telephone operating companies in this country. It is doubtful whether the general public has any idea of the number of telephones in the United States operated by companies not in any way controlled by the American Telephone and Telegraph Company, generally known as the Bell System.

This is probably due to the fact that the associated companies of the Bell System operate the telephone systems in most of the large cities. However, it is interesting to note that on January 1, 1930, uncontrolled Independent operating companies were operating some 4,683,000 telephones in the United States, or approximately 23 per cent of the total telephones in service.

This is more than twice the number of telephones operated by the New York Telephone Company, the largest associated company in the Bell group. It just about equals the total number of telephones operated in the combined states of New York and Illinois, which have more telephones than any other two states in the Union and in which are located our two largest cities, New York and Chicago. We could count all the telephones in 31 of our 48 states in the order of their telephone development starting with Nevada which, with its 13,500 telephones, has the smallest development of any state, and ending with Oklahoma with its 297,000 telephones and then would have to add the 154,000 in the District of Columbia to equal this total figure of 4,683,000 Independently operated telephones. It, furthermore, is about three times the number of telephones operated in all of Canada. It is about nine times the number of telephones operated in all of South America. It is approximately equal to all of the telephones operated in Germany and Great Britain combined, which have in service a greater number of telephones than any other two countries in Europe. It is also nearly equal to all the telephones in service in the rest of Europe, including France, Italy, Spain, Portugal, Switzerland, Belgium, The Netherlands, all the Scandinavian countries, Russia, Poland, Austria, Greece and the Balkan States.

Consideration of these figures leads to the realization that the Independent telephone enterprise in the United States is

*E. R. Stonaker, Consulting Traffic Engineer, Rochester Telephone Corp., Rochester, N. Y.*

an extensive business. The money invested in fixed capital by this group of telephone companies represents a total of over $500,000,000. On the basis of six people to each telephone in service, which is the average throughout the United States, these Independently operated telephones are serving a population of approximately 28,000,000 people. The situation existing between the Independent operating group and the Bell System is probably unique in the history of business enterprise. Originally in actual competition with one another in the same towns and cities, it finally became apparent to the managements of both groups that a single telephone system in any given community was for the best interests of both the public and the telephone companies. Accordingly the group operating the smaller number of stations generally sold its interests in each territory to that group which operated therein the larger number of stations. There are very few places today where two competitive telephone systems are operating.

The word "Independent," as applied to this group of companies operating the 4,683,000 telephones referred to above, means that these companies are dependent upon their own financial resources, have their own individual managements, make their own decisions as to operating policies, and operate according to them, instead of being guided by the Bell System policies. There are, however, toll connections between the two groups and such co-operation as is necessary to give the public of the United States a single, unified telephone service.

Although there are several sizable cities in this country served by Independent companies, those in the Independent group usually operate in the smaller cities, towns, villages and rural communities. They are, therefore, very close to the people they serve and they must consider their operating and other problems from an individual company standpoint rather than from that of a great country-wide system.

It is for this reason that the problem "To dial or not to dial" has become so vital a question with many of them. Largely dependent upon their own financial resources and the money which they obtain for service from their local subscribers or customers, it is vital that they install equipment and adopt operating policies and measures which will be the most economical from the viewpoint of their own individual company, and will enable them to render a satisfactory grade of service at a rate reasonable enough to attract the greatest number of customers.

It is here that the "dial versus manual" problem enters into the picture. To be able to say off-hand, "Dial equipment should be installed here," and "Manual equipment should be installed there," would be in the language of the melancholy Dane's soliloquy: "A consummation devoutly to be wished."

The problem, however, is not so easily solved. The principal problem which the small telephone operating company has to face when considering replacement of its present equipment is the same problem faced by the manufacturer who is considering the introduction of machine equipment to replace manual labor. The fact that such machine equipment will considerably reduce the cost of the article he is producing must be proven to his entire satisfaction b e f o r e he dares adopt it.

This is much more difficult to prove of dial equipment in small towns than in the larger metropolitan centers. The reason for this is two-fold. In the first place the competition for the type of labor to be replaced is not as great and, therefore, the cost of that labor is not as high in the small towns as is the case in the larger cities. In the second place, in the smaller single-office towns all local calls

are completed in the office in which they originate and the labor of but one operator is involved, whereas in the larger multi-office cities, where practically all calls are trunked from one switchboard to another, the labor of two operators is involved on each call.

Although the labor of both of these operators must be replaced by machine equipment when dial replaces manual in the multi-office areas, thus considerably increasing the per-line cost of dial equipment in such instances over a corresponding dial cost in the single office towns, it can readily be seen that an extremely high wage scale has much greater weight in swinging the balance toward dial, when it prevails in the multi-office cities than when it is found in the smaller single office towns. In the last analysis, the controlling factor in any comparison between the two types of equipment, dial and manual, is operator labor cost. Whatever other factors enter into the study are more or less incidental to that main issue.

In only a few of the largest metropolitan centers is this operator labor cost great enough to swing the balance in favor of dial equipment. If the management of the small company should install dial equipment and should find it more expensive to operate, it would be faced with the necessity of increasing instead of decreasing its rates, at the same time placing upon its customers part of the burden of doing the operating, at the same time releasing from employment a certain percentage of its operating force, who probably are the daughters of some of its customers. It is self-evident that such a procedure is not an economical one nor in the best interests of the public being served.

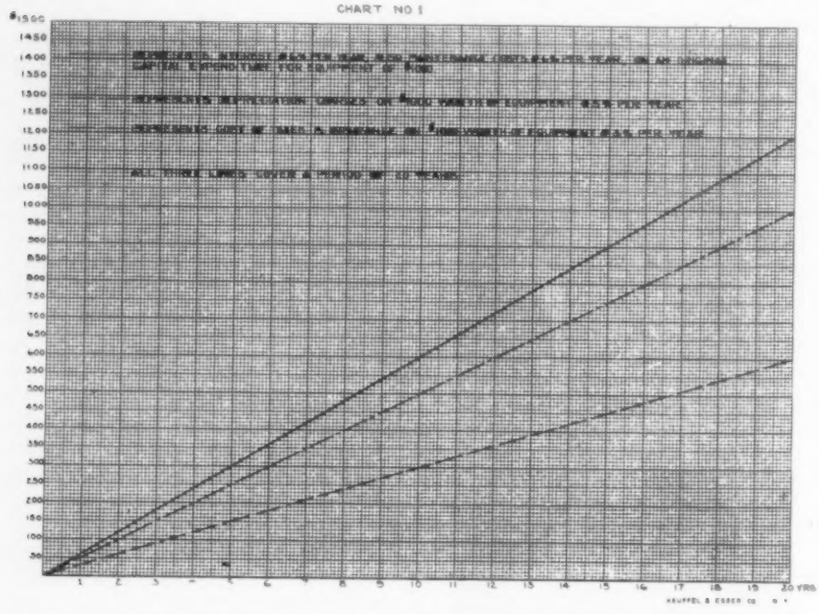
The real economies of dial equipment are open to question. If it were more economical than manual it must naturally follow that the installation of dial equipment in a given system should result in a decrease in telephone rates. Up to the present, however, just the opposite has been the result, in most cases the installation of dial equipment being followed by an increase in rates. It is apparent, therefore, that whatever increased return has been earned on dial equipment by any operating company over what was being earned with manual equipment, is traceable to increased rates rather than to any economy inherent in the equipment itself. It is not surprising that the conservative Independent telephone manager studies the question of type of equipment very carefully, when it becomes necessary to replace the equipment then being used.

It is the contention of the writer that in considering any expenditure for additional plant equipment, it is the height of economic folly for any management to choose the more costly of two or more alternate plans, solely on the basis of a theoretical saving in operating costs which may not be realized for five or ten years after the initial capital expenditure.

Unless a careful study indicates a substantial saving in operating costs beginning immediately upon the installation of dial equipment, it is obviously wiser to install feature or modern manual equipment, which usually requires an initial capital expenditure less than half that required by a comparable dial installation.

In the case of manual equipment a far higher portion of the operating costs consists of labor charges than is the case with dial equipment where fixed annual charges against a capital expenditure already made form the bulk of the operating costs. Thus, operating costs on manual equipment are under much closer control by the operating management than those applying to dial equipment.

The public's preference for dial or manual service, is also a moot question.

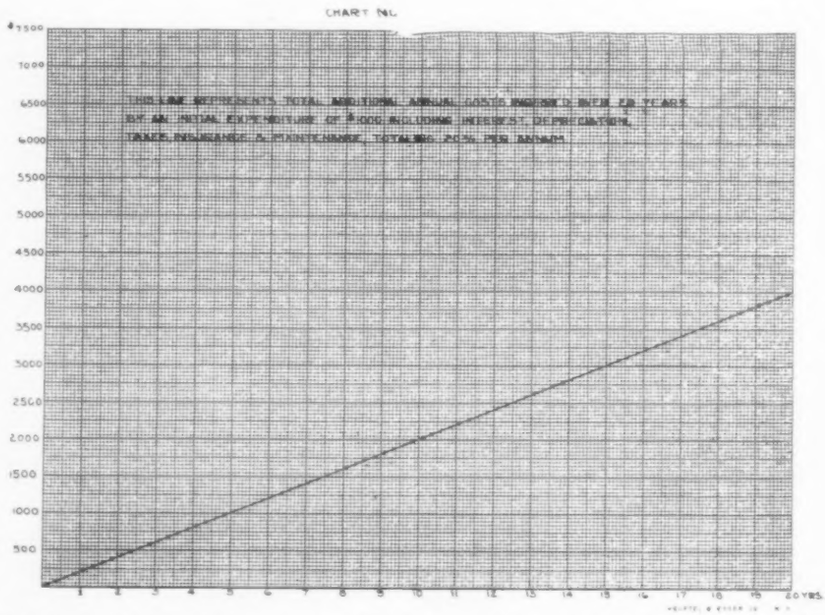



*Line No. 1 represents interest at 6% per year, also maintenance costs at 6% per year, on an original capital expenditure for equipment of* $1,000.

*Line No. 2 represents depreciation charges on* $1,000 *worth of equipment at 5% per year.*

*Line No. 3 represents cost of taxes and insurance on* $1,000 *worth of equipment at 3% per year.*

*All three lines cover a period of 20 years.*




*This diagonal line represents total additional annual costs incurred over 20 years by initial expenditure of* $1,000 *including interest, depreciation, taxes, insurance and maintenance totaling 20% per annum.*

It is naturally a difficult one to answer where only one type, either dial or manual, is available.

Dial equipment has been in use in the Independent operating field since the early nineties. It is a well recognized fact that in cities where there were competing plants—one dial and the other manual—the subscribers to both used the manual service two or three times to one use of the dial service. In the only two cases known to the writer, one in the United States and one in Canada, where the question was submitted to the public as to whether or not the present equipment should be replaced by dial or manual equipment, in both instances the public's answer was against the adoption of dial equipment. Both of these instances occurred within the past two years. This question would certainly be an interesting one as the subject of another Literary Digest poll.

The four principal telephone equipment manufacturing companies, competing for the business of the Independent telephone operating group, are the Stromberg-Carlson Telephone Mfg. Company of Rochester, New York, the Kellogg Switchboard and Supply Company, of Chicago, Ill., and the American Electric Company, of Chicago, Ill.; all three of which manufacture manual equipment, and the Automatic Electric Company of Chicago, Ill., which manufactures dial equipment. The last named company has always been the manufacturer of the original dial equipment, as patented by Almon Strowger, which in the beginning was an Independent product and for many years was used exclusively by Independent operating companies.

The problem as to the type of equipment to be installed has been further complicated in recent years by the introduction of a type of manually-operated telephone equipment, also developed by the Independent operating and manufacturing companies, which adapts many of the automatic features of dial equipment to manual apparatus. It places in the hands of the telephone operator equipment with which she can do a greater amount of work in the same time and with less effort than with the older type of manual apparatus. It is thus possible to handle the same number of calls with about one-third fewer operators than formerly.

The situation which has been brought about by the introduction of this more efficient manual apparatus is interestingly illustrated by the four charts published herewith.

Charts 1 and 2 take an original investment in fixed capital of $1,000, represented, in the case under consideration, by new telephone switching equipment, and carry it over a period of twenty years.

An average useful life of twenty years is assumed for telephone switching equipment as distinguished from the so-called dollar life of such equipment, which would be much shorter—say 12 to 15 years, with a 4 per cent to 6 per cent salvage value at the end of that time. This distinction is quite important, as it naturally affects the rate of depreciation used. The longer useful life of twenty years with no salvage value allowance at the end of that time and the consequent lower depreciation rate of 5 per cent are in rather general use in the Independent telephone field and are accordingly used here.

Chart 1 shows first that the interest charges on this original $1,000 expenditure at 6 per cent each year for 20 years amounts to $1,200. It also shows that the cost of maintaining $1,000 worth of equipment for 20 years at the rate of 6 per cent per year, which is the over-all figure ordinarily applied to telephone central office equipment, is another $1,200.

Chart 1 further indicates that the amount necessary to charge off for depreciation at the rate of 5 per cent per annum, which is the over-all figure usually applied to telephone central office equipment totals, for 20 years, another $1,000. It also indicates that, using the over-all figure of 3 per cent per annum usually applied to represent insurance and tax costs against telephone central office

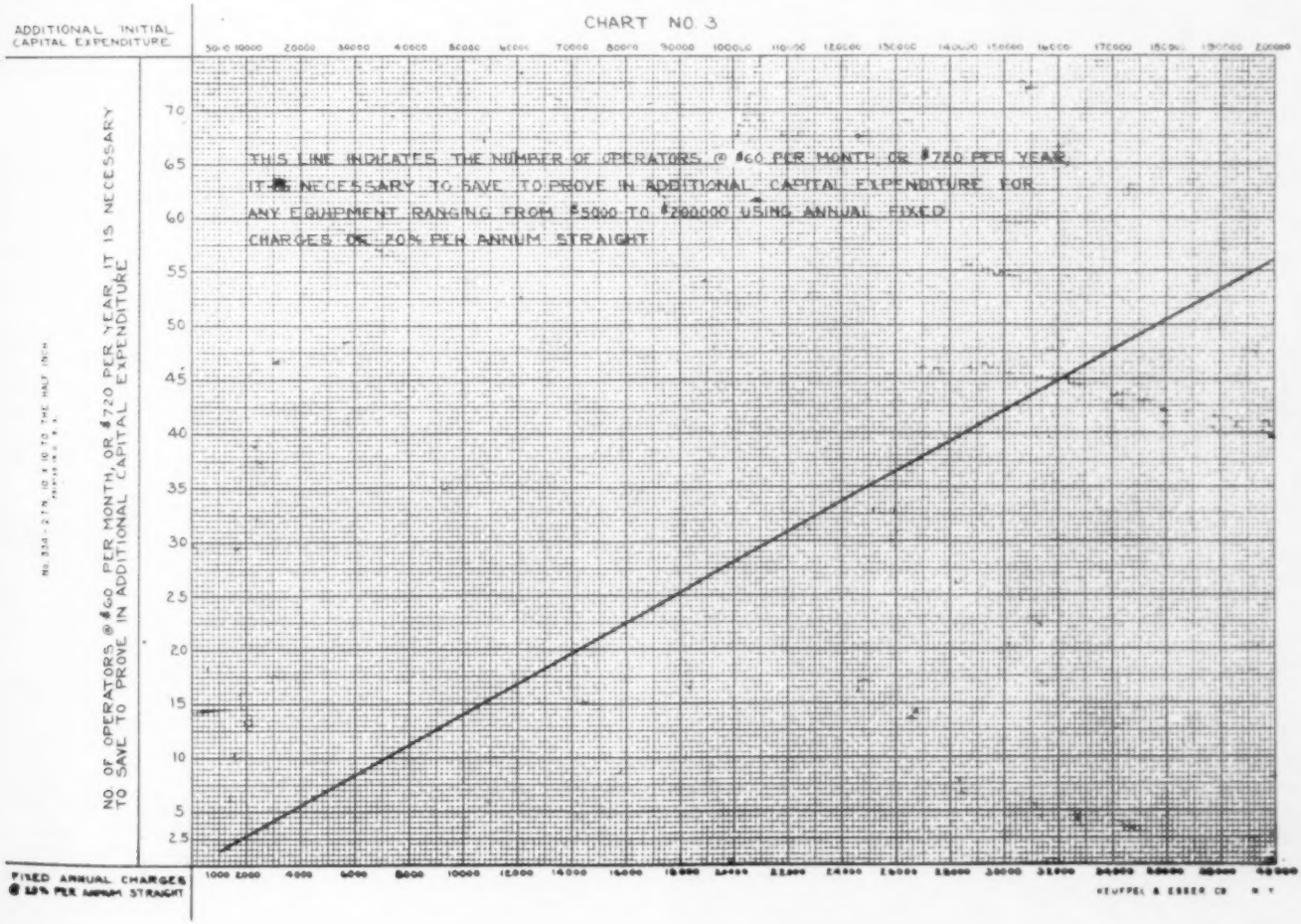


CHART NO. 3
ADDITIONAL INITIAL CAPITAL EXPENDITURE
THIS LINE INDICATES THE NUMBER OF OPERATORS @ $60 PER MONTH OR $720 PER YEAR, IT IS NECESSARY TO SAVE TO PROVE IN ADDITIONAL CAPITAL EXPENDITURE FOR ANY EQUIPMENT RANGING FROM $5000 TO $200000 USING ANNUAL FIXED CHARGES OF 20% PER ANNUM STRAIGHT
NO. OF OPERATORS @ $60 PER MONTH, OR $720 PER YEAR, IT IS NECESSARY TO SAVE TO PROVE IN ADDITIONAL CAPITAL EXPENDITURE
FIXED ANNUAL CHARGES @ 20% PER ANNUM STRAIGHT

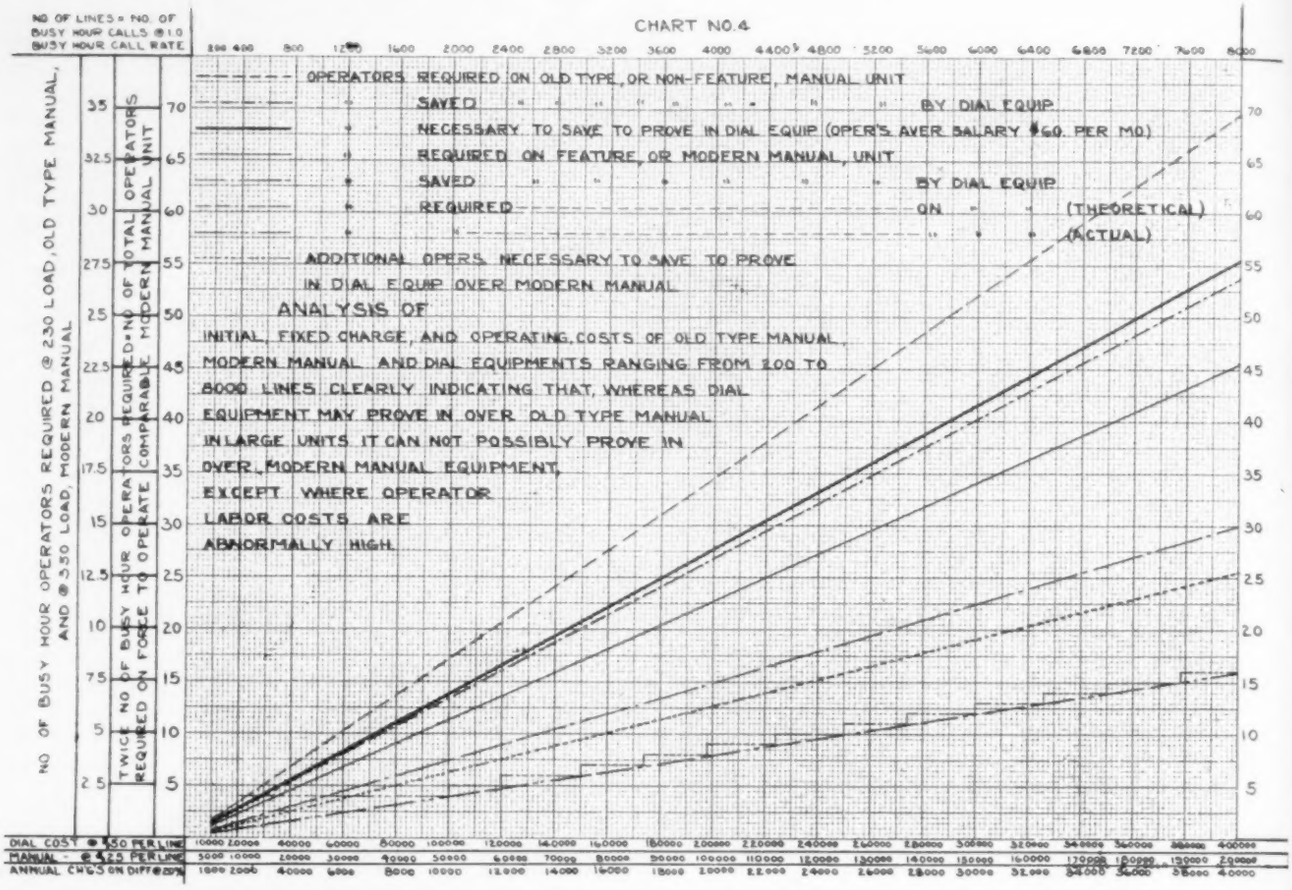


CHART NO. 4
NO. OF LINES = NO. OF BUSY HOUR CALLS @ 1.0 BUSY HOUR CALL RATE
NO. OF BUSY HOUR OPERATORS REQUIRED @ 230 LOAD, OLD TYPE MANUAL, AND @ 350 LOAD, MODERN MANUAL
TWICE NO. OF BUSY HOUR OPERATORS REQUIRED ON FORCE TO OPERATE
NO. OF TOTAL OPERATORS REQUIRED ON COMPARABLE MODERN MANUAL UNIT
OPERATORS REQUIRED ON OLD TYPE, OR NON-FEATURE, MANUAL UNIT
" SAVED " " " " " " " " BY DIAL EQUIP
" NECESSARY TO SAVE TO PROVE IN DIAL EQUIP (OPER'S AVER SALARY $60. PER MO.)
" REQUIRED ON FEATURE, OR MODERN MANUAL, UNIT
" SAVED " " " " " " BY DIAL EQUIP
" REQUIRED ON " " (THEORETICAL)
" " " " " " (ACTUAL)
ADDITIONAL OPERS. NECESSARY TO SAVE TO PROVE IN DIAL EQUIP OVER MODERN MANUAL
ANALYSIS OF INITIAL, FIXED CHARGE, AND OPERATING COSTS OF OLD TYPE MANUAL, MODERN MANUAL AND DIAL EQUIPMENTS RANGING FROM 200 TO 8000 LINES CLEARLY INDICATING THAT, WHEREAS DIAL EQUIPMENT MAY PROVE IN OVER OLD TYPE MANUAL IN LARGE UNITS IT CAN NOT POSSIBLY PROVE IN OVER MODERN MANUAL EQUIPMENT, EXCEPT WHERE OPERATOR LABOR COSTS ARE ABNORMALLY HIGH.
DIAL COST @ $50 PER LINE
MANUAL " @ $25 PER LINE
ANNUAL CHGS ON DIFF @ 20%

equipment, a further total of $600 is spent in 20 years.

Chart 2 is a summary of Chart 1. It indicates that, when investing $1,000 in telephone central office plant, a company is actually contracting to spend, over the 20-year assumed peroid of the useful life of the equipment, a grand total of $4,000 to cover annual fixed charges of 20 per cent for interest, depreciation, taxes, insurance and maintenance, as detailed on Chart 1. The 6 per cent curve shown on Chart 1 must, of course, be used twice, once to represent interest charges and once to represent maintenance charges, to obtain this $4,000 total shown on Chart 2.

The purpose of these first two charts is to illustrate graphically just how much the economies in operating or other expense must amount to in order to justify, solely from the viewpoint of the economics of the situation, an additional initial capital expenditure of $1,000.

Chart 3 merely interprets, in terms of numbers of telephone operators, at an assumed average salary of $60.00 per month, the amount it is necessary to save to justify additional initial capital expenditures ranging from $5,000 to $200,000.

Chart 4 is most interesting. It is a theoretical set-up illustrating graphically the comparative values of the three types of telephone central office equipment; viz., non-feature manual, feature or modern manual and dial. Being a hypothetical set-up, certain assumptions have necessarily been made. These assumptions are, however, based on experience with average conditions in the Independent telephone operating field and apply to local central office equipment and operating costs only, in the case of both dial and manual. Rural, Toll and Miscellaneous costs are left out of the picture. Furthermore, additional sub-station equipment costs have been left out of the dial picture. These figures are, therefore, considered basically sound and, if anything, ultra-conservative. They are, in the main, as follows:

1. Average cost of dial equipment, $50.00 per line.
2. Average cost of manual equipment, $25.00 per line. (This applies to both feature and non-feature manual.)
3. Average fixed annual charges against investment—20 per cent (as covered in Charts 1 and 2).
4. Operator's average salary, $60.00 per month.
5. Average call rate per line—busy hour—1 call per line.
6. Average call load per busy hour operator—Non-feature manual equipment, 230 calls; feature, or modern manual equipment, 350 calls.
7. Average number of operating and terminal room female employes required for each 1,000 lines of installed dial equipment—2 employes.

From Chart 4 we obtain the following data applying to a 2,000 line installation:

| | | |
|---|---|---|
| 1. | Estimated cost of dial equipment | $100,000 |
| 2. | Estimated fixed annual charges @ 20 per cent | 20,000 |
| 3. | Estimated annual salaries of 4 operators @ $720 per year each | 2,880 |
| 4. | Estimated total annual operating cost of dial equipment | $ 22,880 |
| 5. | Estimated cost of manual equipment, old type or modern | 50,000 |
| 6. | Estimated fixed annual charges @ 20 per cent | 10,000 |
| 7. | Estimated annual salaries of 12 operators on modern manual @ $720 | 7,440 |
| 8. | Estimated total annual operating cost of modern manual | $ 17,440 |
| 9. | Estimated annual salaries of 17 operators on old type manual @ $720 | 12,240 |
| 10. | Estimated annual operating cost of old type manual | 22,240 |

The above figures would indicate that, theoretically, it would cost approximately $5,440 or 31 per cent more per year to operate dial central office equipment than to operate modern manual central office equipment, but that dial and old type or

non-feature manual central office equipment shows a fairly even break in annual operating costs. If dial will not prove more economical than modern manual, when central office costs only are considered, it is obvious that the additional substation costs introduced by the use of dial equipment will weight the scale even further in favor of the use of modern manual.

As a check against the figures used in preparing these charts some recent annual report figures of three comparable groups of Independent telephone operating companies were analyzed. This analysis was made as follows: The plants were separated into three groups, based on the type of equipment in use in the largest central office or offices in service; viz., dial, modern manual and old type manual.

In each group the following figures were then obtained:

1. Fixed annual charges against the valuation of total plant investment, or fixed capital, divided into
   (a) Interest @ 6 per cent on fixed capital;
   (b) Taxes and insurance @ 3 per cent on fixed capital;
   (c) Depreciation @ 5 per cent on fixed capital.
2. Controllable expense items divided into:
   (d) Actual maintenance costs reported;
   (e) Actual traffic costs reported;
   (f) Actual commercial and miscellaneous costs reported.
3. By adding these items together for each group a grand total annual cost of operation for each group was obtained.
4. By dividing this grand total cost in each group by the number of stations reported in service in each group, a grand total annual cost of operation per station was obtained. This latter figure was felt to be fairly comparable as among the three groups and actually compared as follows:

| | Modern manual. | Old type manual. | Dial. |
|---|---|---|---|
| Grand total annual cost of operation per station ..... | $32.55 | $39.00 | $43.20 |
| Difference as compared with modern manual costs .... | | + 6.45 or + 20% | +10.65 or + 33% |

It must be remembered, of course, that in the above figures are included the cost of all outside plant in which there is no difference as among the three groups and that if it were possible to allocate in these figures the costs applicable to central office and subscribers' station equipment only the differences shown would be even greater.

As a matter of fact the actual cost figures just above given compare so closely with those used in the theoretical charts 1, 2, 3 and 4 as to leave no doubt that the basis of these theoretical figures is sound and conservative.

It is self-evident that there is just one source from which to obtain the additional revenue indicated as being required to support dial equipment if it is installed, and that is from the telephone subscribers. It must be passed on to them in the form of a proportionate increase in the rates they pay for the service.

It is noteworthy, of course, that Chart 4 is applicable only to installations from 200 to 8,000 lines, in other words, a single office. There also are multi-office points where operator labor is readily obtainable and reasonably low in cost, and where these figures therefore apply with equal accuracy. Since nearly all Independent telephone companies in this country operate plants in the smaller or single office cities and towns, this chart may be said to cover the Independent telephone operating field in the United States. That dial equipment may possibly, in certain isolated instances, demonstrate economy is not denied, for example in situations where the cost of the labor to be replaced will warrant the higher cost equipment. These conditions probably would be found only in the large metropolitan centers. Statements sometimes made to the effect that sufficient labor to operate manual equipment will not be available over a period of the next fifteen or twenty years seem exaggerated. To predicate any action involving the investment of funds in telephone central office equipment, which will probably be in service during this next twenty-year period and which will correspondingly affect the rates to be charged for telephone service during that period, on such an assumption is unsound. It is fully as unsound as it would be to base such action on the assumption either that the late period of extreme inflation or the present period of extreme deflation is, either one by itself, the key to our whole economic structure during the next twenty years.

It is fairly safe to assume that there will be, at least for a long time to come, temporary periods of stringency in labor of all kinds as well as periods when labor will find it difficult to obtain employment at any price. To use either one of these extreme conditions as a premise on which to base the investment of funds in fixed capital, which must remain in the form in which it was originally invested over a considerable period of time, is fundamentally no more valid a proposition than it would be to base such action on the very plausible, but overwhelmingly exploded Malthusian theory that the day is not far distant when we will all starve to death due to an over-abundance of population that it will be physically impossible for the world to support.

In view of the general situation, as revealed by the theoretical and actual figures quoted above, the astute Independent telephone operating company manager and engineer studies his particular problem from all of these angles when faced with the necessity for replacing his present equipment and bases his conclusions, as he properly should, on what is the economical thing to do from the viewpoint of operating costs. The inflated values and distorted viewpoint of the past few years urged many telephone operating managements to give but slight, if any, consideration to the original and operating cost of the equipment which they installed, the thought apparently being that any increase in these costs could be passed on to the public in the form of increased rates which they would readily accept due to the generally prevailing high level of prosperity. With the return to a more normal condition and a saner viewpoint such costs are going to be scrutinized much more closely and will not be incurred unless they spell real economy.

It can readily be seen, therefore, that it is not likely that there will be, in the Independent telephone operating field at least, a general conversion either to one type of equipment or another. For years to come, judging from all that can be foreseen at the present time, there will, in the writer's judgment, be in service in the territories operated by the Independent telephone companies manual equipment in some places and dial equipment in others, depending upon which one, granting that they both give a satisfactory grade of service, is the more economical from the viewpoint of the public being served.

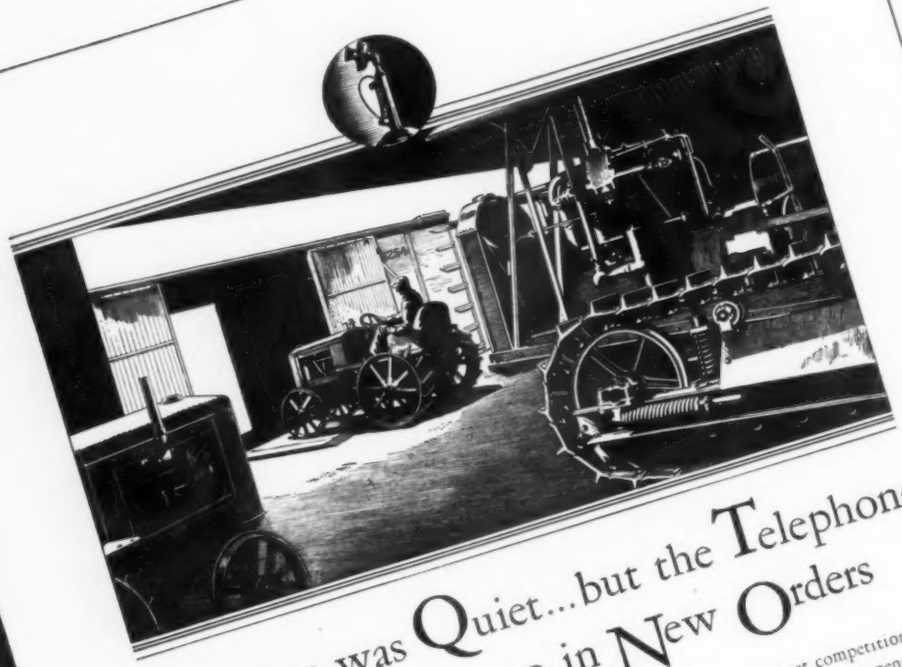
## BUILD $20,000 LINE TO CONNECT ONE TELEPHONE

A new telephone line, 26 miles long, constructed at an estimated cost of $20,000, now connects one telephone in the village of Grand Marais with the outside world. Grand Marais has been without telephone service since 1927 when fire destroyed the line from Seney, Mich. The one instrument in the town is now in the Green Shingles hotel.

## KEEPING THE JOB IN THE FAMILY

Hugh Raney, former owner and manager of the Jasper Telephone Company, St. Joe, Ark., has again assumed its management. He succeeds his brother, Albert Raney, present owner of the company. The latter will devote his entire time in the future to his real estate business.

# Showing the Busin



## Business was Quiet...but the Telephone brought $22,200 in New Orders

A TRACTOR company's sales had fallen off to a marked degree. A telephone sales program to distant customers was decided upon. One result was $18,400 worth of business. Another, a $3,800 order after the purchaser had refused a personal interview.

An Eastern lumber company regularly "visits" lumber yards in five states by telephone. In one month 550 carloads of lumber totaling nearly $500,000 were sold by this modern method. Toll bills averaged less than one-half of one per cent.

Business firms, large and small, are using out-of-town telephone service more than ever to increase sales . . . reduce distribution costs . . . meet competition. New markets are developed at little expense. Customers and prospects are economically contacted between salesmen's visits.

Develop your business by telephone. Best results are obtained by having a definite plan for executives and salesmen to follow. Your local Bell Telephone Business Office will gladly submit a plan to meet your needs.

Inter-city calls are cheap, definite, resultful. Typical station-to-station day rates: Pittsburgh to Indianapolis, $1.50. Boston to Atlanta, $3.50. New York to Baltimore, 90c. Philadelphia to Seattle, $8.50. Bell Telephone service is *Quick . . . Convenient . . . Universal.*

# World hat Long Distance can Accomplish

ALL BUSINESS is interested in economy and cost cutting—particularly under present conditions. Long Distance telephone service, properly applied to business, effects considerable economies of time and money. That fact, presented in advertisements similar to the one on the opposite page, is influencing business men everywhere to acquire the Long Distance habit.

The strength of such advertising lies largely in its simplicity and restraint. Authentic experiences, gathered by operating telephone companies, prove that greater profits and increased efficiency result from intelligent use of the telephone on calls to distant points. They show its application to buying and selling, and to special situations of all kinds. Briefly and clearly, with definite figures, they tell their story.

On occasion, specific rates are quoted to show the low cost of the service. Supplementary advertisements present Telephone Typewriter Service, the Key Town Plan and other special services. Usually there is a direct reference to the local telephone office and the valuable assistance available there upon request.

This advertising is appearing regularly in both national publications of general character and in business and commercial publications. Its continued appearance is bound to encourage the users of telephones—whether Bell or connecting company—in the worthy Long Distance habit.

*An Advertisement of the American Telephone and Telegraph Company*

# Resistance Measuring Instruments for Telephone Testing

**The Principal Types of Apparatus for Telephone Testing Are Reviewed by B. C. Burden, Transmission Engineer, Lincoln Telephone and Telegraph Co., Lincoln, Nebr., with Special Reference to the Circuit Tester, or Portable Ohmmeter Type.**

### General

The measurement of circuit and equipment resistance is an important part of general telephone testing in connection with fault location and telephone plant maintenance.

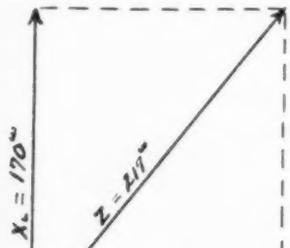



*Fig. 1*

It is true that the resistance only tells part of the story, as equipment and circuits may, and usually do have, inductance and capacity, in addition to resistance.

However, in the majority of cases a resistance measurement is sufficient to permit the location of trouble, or to determine the circuit condition.

In speaking of resistance we should differentiate between "direct current (or true) resistance" and "alternating current (or effective) resistance." *Direct current resistance* is the opposing effect offered to a constant value direct current due to the physical properties of the conductor considered. For a given conductor the value is independent of voltage or current, but will vary with temperature. *Alternating current resistance* represents the opposing effect offered to a varying direct current or an alternating current due to the physical properties of the conductor considered, plus that due to hysteresis and eddy current power loss in the medium surrounding the conductor. This type of resistance varies with both temperature, frequency, and character of surrounding medium.

Alternating current resistance should not be confused with reactance or impedance. The following data should indicate the difference between D. C. resistance, A. C. resistance, inductance, reactance, and impedance. A certain type of telephone receiver has a D. C. resistance of 80 ohms, an A. C. resistance of 135 ohms, a reactance (inductive) of 170 ohms, an impedance of 216 ohms, and an inductance of .03 henries. These values are based on 800 cycle measurements.

The 80 ohms represents the true resistance of the wire in the receiver coils. The following vector diagram illustrates the angular relation of the above components (Figure 1).

### Three Types of Resistance Measuring Instruments

But let us get back to our consideration of resistance measuring instruments. There are three commercial types of instruments for measuring resistance. which are:

1. The Wheatstone bridge.
2. The true ohmmeter (more familiarly known as "the megger").
3. The direct reading ohmmeter.

*Fig. 2*

Resistance may also be determined indirectly by voltmeter and ammeter readings; however, this method is not suitable for general testing work.

### The Wheatstone Bridge

The Wheatstone bridge constitutes the most accurate all range resistance measuring instrument available, but in addition to requiring a certain amount of skill in operation, is too costly for general circuit testing purposes.

Figure 2 shows the schematic circuit of a Wheatstone bridge. The bridge consists essentially of three variable, non-inductive resistance arms referred to in the diagram as A, B, and R, a sensitive galvanometer, and a low voltage battery. The variable arms A and B each have four resistance values which may be selected by a dial switch. Their values are usually 1, 10, 100 and 1000 ohms. The R or rheostat arm is arranged to be variable in steps of one ohm from 1 to 10,110 ohms. The theory and method of operation are as follows: The resistance to be measured is connected to terminals $X_1$, $X_2$. The ratio arms A and B are adjusted so that a ratio is selected which is most suitable for the resistance to be measured. This ratio is determined by the following table:

| Range in which unknown resistance is thought to fall | Ratio arms A | B |
|---|---|---|
| Less than 10 ohms | 1 | 1000 |
| 10 to 100 ohms | 10 | 1000 |
| 100 to 1000 ohms | 100 | 1000 |
| 1000 to 10,000 ohms | 1000 | 1000 |
| 10,000 to 100,000 ohms | 1000 | 100 |
| 100,000 to 1,000,000 ohms | 1000 | 10 |
| 1,000,000 to 10,000,000 ohms | 1000 | 1 |

The rheostat arm is then varied until the galvanometer will give no deflection when the battery circuit is closed. The bridge is then said to be balanced, and the value of the unknown resistance connected to terminals $X_1$, $X_2$ can be determined by the following simple equation:

$$X = \frac{AR}{B}$$

where X = unknown resistance
A = resistance in A
B = resistance in B
R = resistance in R

The electrical conditions which prevail with the bridge balanced can be readily understood by considering the drop in potential across each arm, with

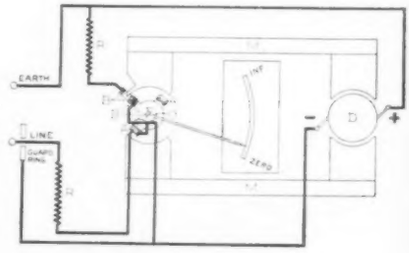



*Fig. 4*

the galvanometer circuit open. From ohms law we know that the voltage drop across any resistance is equal to IR. Now if the resistance of arm A is to B as X is to R, the IR drop across arm A and B will be equal, and the galvanometer when bridged across these two arms will show

no deflection as the potential across the galvanometer would be zero. Wheatstone bridges are most useful in connection with fault locations on cable or long open wire circuits where extreme accuracy is desired.

**The True Ohmmeter or Megger Type Instrument**

The second class of resistance measuring instruments is the "true ohmmeter" type. One of the best known makes of this type of instrument is "the Megger."

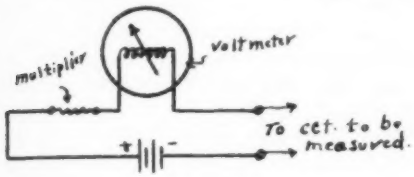



*Fig. 6*

Figure 4 illustrates the schematic circuit of this instrument. You will note that the instrument consists essentially of a D. C. generator, and an indicating meter actuated by the flux from a current and a potential coil, both mounted on the same shaft. With no resistance connected to the measuring terminals $X_1$, $X_2$ the moving potential coils will tend to assume a position embracing the least number of lines of force from the permanent magnet, when the generator is operated. The indicator needle is so attached that under this condition it will indicate infinite resistance.

When a resistance is connected to the terminals $X_1$, $X_2$ the voltage from the hand operated generator will set up a current through the resistance via the current coil, in addition to that which normally flows through the potential coil due to the impressed voltage. This current will set up a flux in coil A in opposition to that in coil B and the resulting torque will cause the coils and indicating needle to assume some new position between the infinity and zero ends of the direct reading ohm scale.

The dial over which the needle moves is calibrated so that the value of the connected resistance is indicated directly by the needle.

It might seem at first thought that the reading would vary depending on the speed of the D. C. generator. This is not true, however, as the reading is absolutely constant regardless of the voltage applied to the coils. The fact that the voltage across the potential coil and current through the series coil both vary at the same rate makes the instrument independent of voltage. This type of instrument really measures the ratio of voltage divided by current or R, hence its name the "true ohmmeter."

The "Megger" type of resistance measuring sets have the greatest field in use in connection with ground electrode measurements, insulation testing of cables, and the accurate measurement of high or low insulation testing of cables, and the accurate measurement of resistances of any voltage in connection with shop work. They can be obtained with dual ranges so that either small or large resistances can be conveniently measured.

For the measurement of resistance to earth of ground electrodes, a special model is available which not only permits a direct (single) reading using two auxiliary grounds, but also eliminates any possibility of error due to ground potentials. This last feature is accomplished by means of reversing commutators which pass alternating current through the ground electrodes, but direct current through the moving coils. Like the Wheatstone bridge the "Megger" type instrument is too expensive and bulky for general circuit testing, but is unexcelled for insulation resistance measurements, ground electrode to earth measurements, and other similar work.

**The Voltmeter Type of Ohmmeter**

The most simple and flexible arrangement for general circuit testing and resistance measurements for use in telephone plant maintenance is an ordinary voltmeter in series with a battery.

Figure 6 illustrates this type of measuring circuit. It will be noted that in measuring an external resistance, that the current from the battery flows through the meter and through the external resistance in series. It is obvious that the greater the external resistance the smaller

*Fig. 7*

will be the current in this series circuit, and with a smaller current through the voltmeter we of course get a lower reading.

The resistance which is connected across the external circuit can be determined by the following simple equation:

$$R_x = \frac{(E - E_v)}{E_v} R_v$$

where $R_x$ = unknown resistance
$E$ = battery voltage
$E_v$ = voltmeter deflection
$R_v$ = resistance of voltmeter

The resistance measuring range of the voltmeter-battery combination will depend on the resistance of the voltmeter used and the voltage of the testing battery. It is evident from the above equation that the higher the resistance of the voltmeter the greater will be the overall resistance range of the instrument. But, on the other hand, the higher resistance meters will give a larger change in resistance values between adjacent scale divisions, thereby affecting the ease and accuracy with which the meter may be used.

The voltmeter type of ohmmeter is

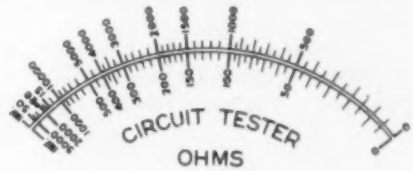



*Fig. 7-A*

almost universally used as a wire chief's testing arrangement. For some unknown reason voltmeters used for this purpose are seldom calibrated in ohms. The reason given is that it would be confusing when the test battery voltage was above or below normal. The convenience of having a direct reading ohm scale would easily justify the necessary effort required in keeping test battery voltages at the right value. For that matter there is no good reason why the moving coil of the voltmeter could not be shunted with a variable resistor of such value as to permit sufficient adjustment to take care of small battery fluctuations without materially upsetting the accuracy.

**The Portable Ohmmeter or Circuit Tester**

By the use of a small panel type voltmeter and one or two flashlight cells it is feasible to fix up a small compact testing unit which permits a troubleman to carry the equivalent of a wire chief's test panel in his coat pocket. Such testing units have become very popular the last few years and deservedly so. They are pronounced as "indispensable" by all who have used them in general trouble location work. They are particularly useful to the smaller exchange managers who, when out on trouble, have no one in the office to operate the regular wire chief's test circuit.

It was formerly necessary to build up these portable ohmmeters or *circuit testers*, as they might more aptly be called, as no factory built units were available. A Weston 0 to 3 volt voltmeter in series with two small flashlight cells has always been a favorite with those constructing such units. Recently, however, the electrical instrument manufacturers have brought out complete self contained direct reading ohmmeters, which have a number of advantages not possible with the assembled units.

The most recent instrument of this type is the Weston Electrical Instrument Company's Model 563 *Circuit Tester* shown in Figure 7. This instrument, which was designed especially for tele-

phone and radio circuit testing, leaves nothing to be desired. Aside from its excellent appearance and compact design, it has the following features which make it especially well adapted for the telephone maintenance man.

1. It reads directly in ohms and requires no external battery.

2. It has two scales which permit the accurate measurement of both low and high resistances. The resistance ranges are so designed as to be most suitable for telephone testing requirements.

3. The current passed through the circuit being measured is very small, being only 1 milliampere on the high resistance scale, and 10 milliamperes on the low scale.

4. Variations in battery voltage can be compensated for by means of an adjusting screw.

5. The low resistance scale is so arranged as to permit accurate determination of wire resistance on mile by mile checks of iron wire lines.

6. The low voltage used (1.5 volts) will not "break down bad splices," or contact trouble.

Some of the tests for which the "Weston Circuit Tester" is particularly well adapted are as follows:

*Line Tests.*—Testing for shorts, grounds, or opens.

The *circuit tester* may be used directly from the switchboard in small offices not equipped with a regular wire chief's voltmeter. Figure 8 shows how a switchboard cord and plug may be wired up to a test block to which the *circuit tester* is connected so that metallic lines may be rapidly connected for short, ground on tip, or ground on ring tests. Such an arrangement is very convenient in connection with the maintenance of small exchanges which are visited only occasionally by trouble men from nearby exchanges, and with such an arrangement, no equipment is tied up at such offices except a cord, plug and switching key.

*Line Resistance Checks.*—The *circuit tester* is particularly valuable in locating high resistance splices in rural iron wire circuits. Overall resistance measurements should first be made, i. e., from cable terminal out to a short at the first telephone on the line. If the results check fairly close to the computed resistances then no further measurements are necessary, but if the measured value is considerably higher than the computed resistance, then a mile by mile check should be made to locate the offending splices.

In making mile by mile checks, connect the *circuit tester* across the line wires and have a helper apply a short at

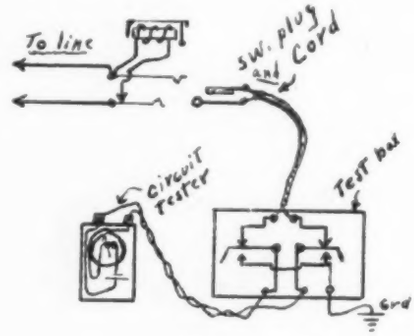



*Fig.* 8

a point a mile away. If the resistance does not measure sufficiently close to the theoretical value (67 ohms for No. 12 iron per loop mile), then the short should be applied at various points in the section between tester and helper until the high resistance spans are located.

On grounded circuits when there are more than one wire on the lead, tests can be made in the same way as described above, using two different line wires. On single wire grounded circuits approximate results can be obtained by measuring as long sections as possible, and assuming the grounds will introduce about 30 ohms at each end. The actual ground electrode-earth resistance may vary widely. The resistance to earth of the ground electrode can of course be determined using two auxiliary grounds and the "triangulation" formula.

In testing on sections of rural line having bridged subset ringers (1600ω) between tester and short, it will be necessary to subtract .5 ohm from the reading obtained, for each bridged ringer. It is desirable that no ringers be bridged across the line between tester and central office, and if they are, one side of the line should be opened so that the test will indicate only the resistance between tester and short. A 4 M. F. condenser placed in series with one side of the line as shown in Figure 9 will keep the switchboard drop from affecting the tests and yet not interfere with talking and signaling on the line while it is being tested.

It is of course necessary that all receivers of sets bridged across the line, between tester and short, be on the hook, otherwise inaccurate measurements will be obtained.

By means of the above tests, and the removal of bad splices, the transmission on old iron wire can be improved until equal to that of new wire. No company having rural iron wire or toll plant to maintain can afford to be without a *circuit tester*.

*Subset Tests.*—Another use of the ***circuit tester*** which makes it indispensable to the troubleman in a magneto plant is for checking subset resistance. On multiparty lines trouble in a single telephone may throw the entire line out of service. By merely clipping the ohmmeter across the line terminals of the telephone (and opening one side of the line) five tests can be quickly made which will indicate the presence of trouble in the subset. These tests are as follows:

(*Continued on page* 38.)

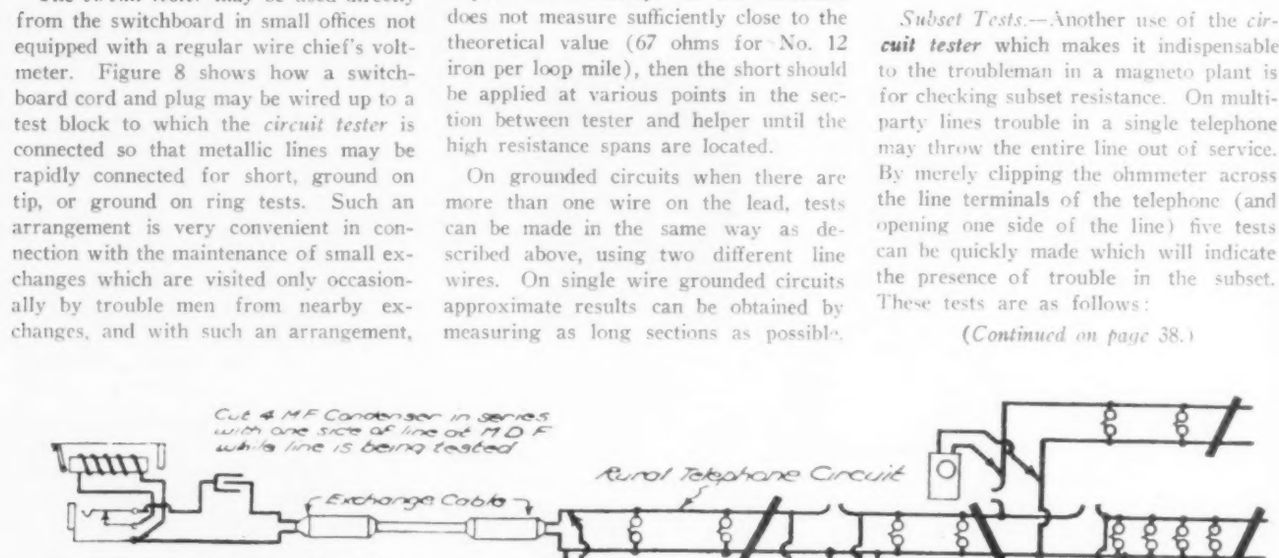

Cut 4 M.F Condenser in series with one side of line at M.D.F while line is being tested
Exchange Cable
Rural Telephone Circuit
Note 1. Add .5ω to reading for each bridged 1600 ω ringer between tester and short.
Note 2. In making tests on sections of line in which there are telephone legs on the side away from tester and short, then line must be opened as shown.
Note 3. Shorting wire can best be made by using short piece of lamp cord and with wing nut clamp on each end.
Note 4. The 4 M.F Condenser should be cut in series with one of the line wires either at M.D.F. or cable terminal. Four 1 M.F. condensers in multiple will give 4 M.F.
Ohmmeter
Short applied by helper

*Fig.* 9

# Casual Glimpses of Telephone Methods

**Ray Blain Takes an Automobile Trip and Records by Note-book and Camera the Unusual Features of Line, Pole and Cable Which Attract His Attention En Route; Occasionally Criticizes Work and Equipment and Offers Constructive Suggestions.**

The telephone man often resembles the postman, who took a long walk on his day off. For the telephone man when he goes for a drive usually has a pole line and wire to keep him company. On a recent automobile trip I found many things which interested me from the point of view of a telephone man and I will attempt to show them to you through the eye of the camera.

The first thing I noticed was a trench being dug by hand for a new conduit line. Some of the creosoted wood conduit had already been laid. I suppose hand digging is necessary in some cases but it does seem like waste of labor when a baby trencher will do the job quickly and easily.

Then I noticed an aerial corner of a type I had never seen before. This type corner was necessary so that the poles would clear an alley entrance. The cable was suspended about eight feet from each pole by a piece of messenger and looked somewhat like trolley construction.

Next came an alley arm of the usual construction necessary to put a pole in the clear but still permit the cable to take a straight line. Although this is nothing new it is somewhat rare, so I recorded it on the film of my camera.

The next stop was something out of the ordinary as it consisted of an "H" fixture with both guys and pole braces. I can't say exactly what the engineer's idea could have been, but the purpose of the fixture was to support a long span of copperweld over a river and it certainly seemed sufficiently firm and solid. The extra long span was up in good shape and no doubt had been in service several years.

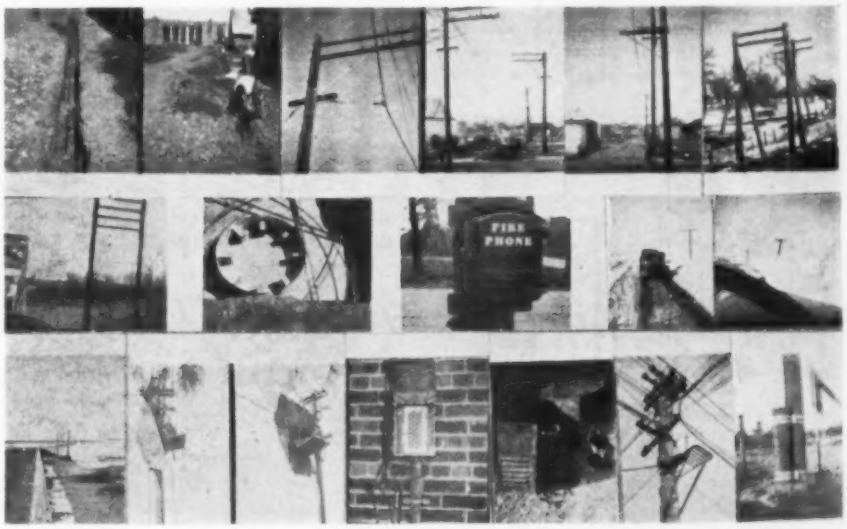
The next river crossing had the usual "H" fixture but without the braces, but the numerous guys and anchors apparently were holding fine.

A short ride from here brought me to another underground cable job under construction, so I stopped to look at some manhole forms in place, ready for the concrete. They had done a very good job, but how much better, cheaper and quicker would have been the iron knock-down type manhole forms. I don't believe there is a more difficult job on earth than to take a wood form out of a manhole after the concrete has set. It is much simpler to set up and take down the iron type form.

While traveling through a small town I snapped a picture of a mine type telephone installed for fire reporting purposes. The thought came to me that more use should be made of this type instrument in locations where the life of the ordinary instrument is comparatively short, due to temperature or moisture. Probably there are also many small towns and villages without a fire alarm system where a few of these instruments could be installed to advantage.

Next I noticed a cable terminal on a building with the riser pipe running directly to the bottom of it. An examination proved that the cable had been spliced to the terminal stub and then pulled into the pipe before the terminal was mounted. This made a very neat job.

Driving on over the hard-packed snow, I saw another splicer working, who was trying to use a worn out furnace and a one of the regular splicers' tents which clamp to the messenger and tie to the platform.




*A few pictures Mr. Ray Blain snapped while on his sight-seeing trip*

Night came on, so I found a place to park the car and a place to sleep. Continuing my journey the next morning, a few hours' drive brought me over the Colorado line and I soon came onto large snowdrifts, as a severe storm had just passed over this region. Snow plows had been at work and I didn't have any particular difficulty in getting through, but couldn't resist the temptation of snapping a couple of pictures through the windshield of telephone poles almost concealed by drifts. Temporary repairs had been made but many poles were still down and I did not envy the line gang their job of resetting them in such real winter weather.

It was a cold day but I noticed a cable splicer working on an aerial platform with only a tarpaulin for a makeshift shelter. He was obviously suffering with the cold and I knew he would appreciate Ford hood for a windshield. What a help a modern furnace and a shield would have been to him!

A little farther on I stopped to take a picture of an old cable terminal and an older pole balcony or seat. Seats are so seldom used nowadays on poles with small cable terminals that this was a novelty.

The last picture taken was of a stubbed pole, on which the new type stubbing clamp had been used. I will never like a stubbed pole as well as a new one to replace the pole which has rotted off, but then if one must stub I would much prefer this new style clamp which is a great improvement over the old wire wrap method.

Well, it was a good trip in spite of the snow and cold. Saw a lot of telephone things and perhaps picked up a few ideas which will be useful later on.

# VACUUM TUBE THEORY AND PRACTICE

## AS APPLIED TO THE TELEPHONE CIRCUIT

### General

The vacuum tube is becoming increasingly important in telephone practice and an understanding of its use and operation is desirable for telephone men who wish to keep abreast of the latest developments.

Vacuum tubes are used in telephone repeaters, carrier systems (both telegraph and telephone) audio amplifiers for public address systems, audio amplifiers for use in cable fault location work, audio oscillators for furnishing a constant tone for testing purposes, etc. The future will undoubtedly bring forth many other interesting applications of the vacuum tube in the telephone industry.

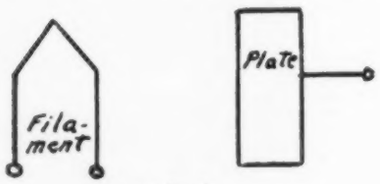



**Fig. 1.**

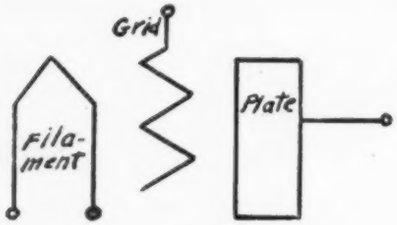



**Fig. 2.**

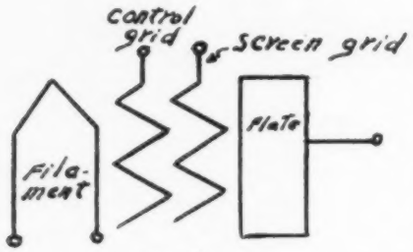



**Fig. 3.**

*Top—Schematic of two element vacuum tube. Center—Schematic of three element vacuum tube. Bottom—Schematic of screengrid tube.*

### Types of Vacuum Tubes

There are three fundamental types of tubes, viz., the two element, the three element, and the screen grid tube. (There are also several other types differing somewhat from these three and they will be discussed in a later article.)

1. The two element tube consists of a filament and a plate as shown in figure 1. These elements are enclosed in a glass bulb having a high vacuum.

2. The three element tube consists of a filament surrounded by a control grid, and this grid in turn being surrounded by a plate element, as shown in figure 2.

3. The screen grid tube is similar to the three element tube except that a screen grid is interposed between the control grid and the plate, as shown in figure 3.

The filaments of present-day tubes are usually coated with a chemical having excellent electron emitting properties. This permits burning the filaments at lower temperatures and hence lower current consumption. The principle coatings used are thorium and oxide. Barium is also used to increase the electron emission.

A. C. tubes differ from D. C. tubes chiefly in their filament construction. A heavy filament with a low voltage across it is used in order to reduce the magnitude of the temperature change when the filament is passing through zero voltage.

A special tube for A. C. use is available and is known as the "heater cathode" type. This tube has a metal tube (cathode) which surrounds a heavy filament heated by alternating current. The metal tube is heated by the proximity of the filament and thus gives off electrons. This type of tube is very quiet from the standpoint of AC hum, and can be used as a detector tube more successfully than the regular AC filament type.

### Theory of Vacuum Tube Operation

The filament of a vacuum tube when heated throws off electrons (invisible particles of electricity). These electrons, which are always negative, will be attracted to any positively charged body nearby. In the two element tube a positive voltage is connected to the plate and a current flow then takes place from filament to plate due to the attraction of the negative electrons by the positively charged plate. The movement of the electrons from the filament to the plate results in a current flow in the series circuit consisting of the plate, plate battery, filament, and the vacuum gap between the filament and plate. This current flow due to the attractions of the emitted electrons by the positive plate is similar to the assumed movement of electrons in a metallic conductor to which a source of voltage is connected.

Now if the voltage on the plate is reversed with respect to the filament, that is, made negative, the current flow will cease inasmuch as the plate cannot throw off electrons. We can, therefore, see that a vacuum tube is a one way current device or rectifier. The two element tube is widely used as a rectifier both in broadcasting stations and in receiving sets. Figure 5 shows how the two element tube is connected as a rectifier for both half wave, and for full wave rectification.

The three element tube acts in the same manner as the two element tube as to rectification but in addition has a control grid which is located around and much closer to the filament than is the plate element.

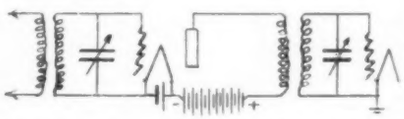


*Fig. 4-A—Three element tube in typical radio*

To understand how the three and four element tubes work we must consider first the "space charge effect." When the filament of a tube is at the proper temperature negative electrons are given off and most of these are attracted by the positively charged plate. All of these negative electrons are not attracted to the plate, however, and some will remain in the vicinity of the filament. The effect of these negative electrons in close proximity to the filament is to reduce the total plate current that would flow were they not there. The effect they have on the operation of the tube is referred to as "the space charge effect."

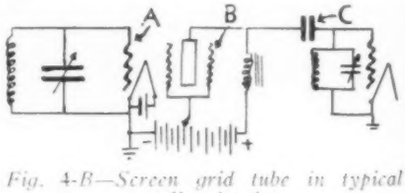



*Fig. 4-B—Screen grid tube in typical radio circuit*

Now in the three element tube the control grid is located much closer to the filament than is the plate, hence small variations in the magnitude and direction of the voltage on this grid will bring about correspondingly larger changes in the plate-filament current. This action is due in part to the neutralizing effect of the grid input voltages on the "space charge." That is, when the grid is negative the effect of the space charge would

be increased and less current will flow between the filament and plate. Conversely when the grid is positive, the negative space charge will be practically neutralized and more current will flow between plate and filament. (There would also be a grid-filament current flow due to the grid being positive.)

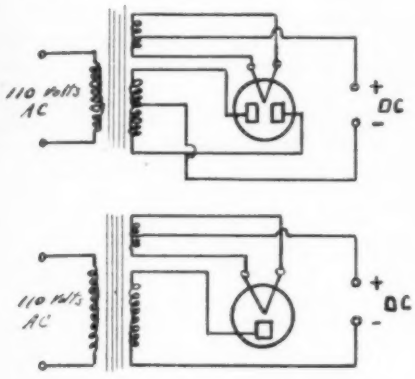



*Fig. 5.—The two element tube used as a half and full wave rectifier*

It is therefore evident that small voltage variations applied to the grid of the three element tube will set up larger voltage variations in the plate circuit.

The screen grid or four element tube is one of the more recent additions to the tube family. By means of the "screen grid" which is interposed between the control grid and the plate, as shown in figure 3, a reduction in the capacity between plate and grid is affected and in addition the gain or amplification factor of the tube is greatly increased. This

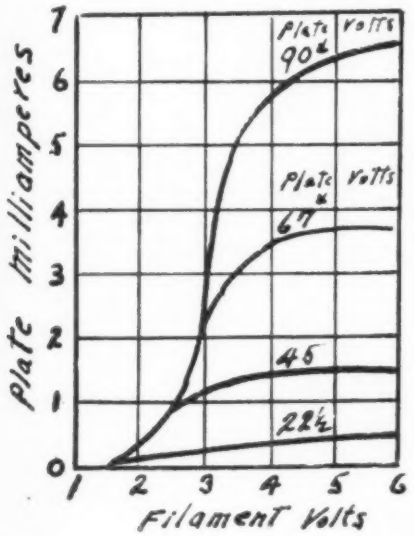



*Fig. 6.—Filament voltage. Plate current characteristic curve for Type 201-A tube. (Three element tube.)*

greater amplification factor results from a partial neutralization of the "space charge by the positive voltage on the screen grid." The reduction of the capacity between plate and grid reduces the tendency of radio frequency tuned stages to oscillate.

The screen grid is operated at a lower positive voltage than the plate. The screen grid tube has a high impedance, being of the order of 400,000 ohms for the UY 244. The amplification factor is around 400. These tubes have great possibilities for both radio and audio frequency amplification, and most modern receivers are using them. They have not received much use in the telephone field up to the present time.

Fig. 4-A and 4-B illustrate typical circuits in which the three and four element tubes are used.

**Vacuum Tube Characteristic Curves**

In the operation of a vacuum tube the relations that exist between the currents and voltages in the grid, filament and plate circuits can be most adequately expressed and understood by means of a series of "characteristic curves."

The first of these is the *plate current-filament voltage curve* (see figure 6). You will note from this curve that for a fixed plate voltage the plate current will increase for increases in filament voltage up to a certain point after which the curve flattens out and a further increase in filament voltage does not perceptibly increase the plate current. The point at which the curve flattens out is referred to as the "saturation" point. It is evident that *tubes should be worked at filament voltages which throw the operating point up on the saturated part of the curve*, so that small changes in filament current will not cause plate current variations.

You will also note from this curve (figure 6) that increasing the plate voltage raises the knee of the curve considerably so that a higher filament voltage up to some new saturation point will give increased plate current. The "saturation effect" is due to the fact that as the filament temperature is increased by increasing the voltage across it, a point is reached where the plate is taking all the electrons it can attract through the space charge hence further increase in temperature of the filament is ineffective in causing additional current flow between the filament and plate. But as the plate voltage is raised the effect of the space charge is reduced and the saturation temperature raised.

The second curve (figure 7) shows the effect of increasing the plate potential, with fixed grid and filament voltages. Although not shown on the curve, the saturation point is reached where the curve flattens out, and thus increased plate voltages are ineffective in producing increased

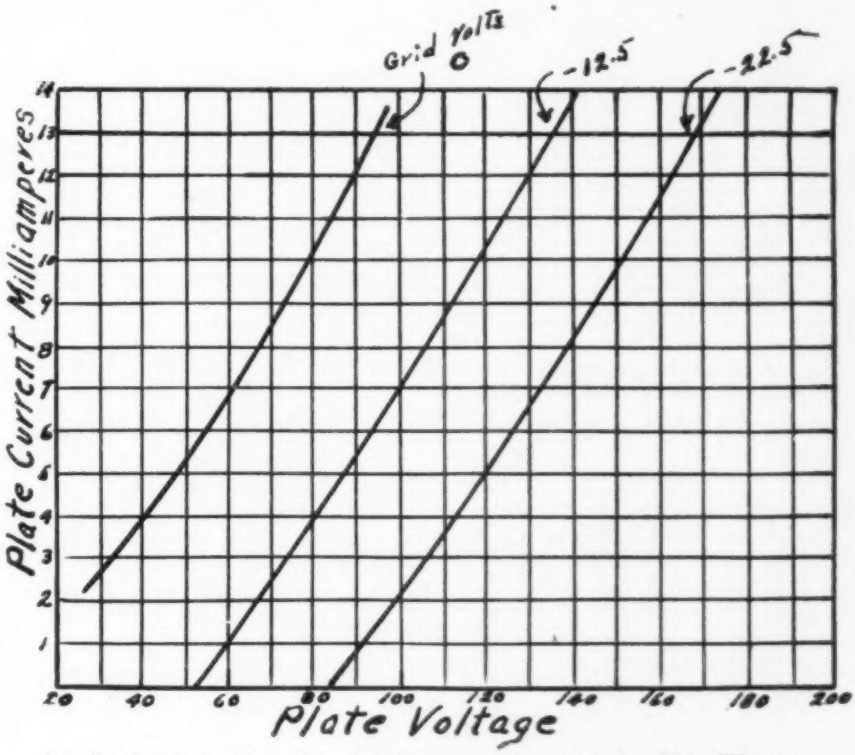



*Fig. 7.—Plate current. Plate voltage characteristic curve for Type 220 tube. (Three element tube.)*

plate currents. This saturation point is reached when the plate potential is such that it attracts all the electrons emitted by the filament. In operation it usually is desirable to *work tubes well below this saturation point.* This curve is known as the *plate current-plate voltage characteristic.* Such curves are very useful in determining the tubes constants, and their behavior when connected in a circuit with other equipment. The curves are plotted with plate current as ordinates and plate voltage as abscissa and with various assumed grid potentials.

The third curve, figure 8, shows the *grid voltage—plate current* characteris-

tics of the three element tubes. From these curves it will be seen that with high negative grid voltages but little if any plate current flows, but as the grid voltage is made less negative, the plate current increases, first slowly then more rapidly, until the curve has a uniform slope indicating a uniform change between grid voltage and plate current variations. (This straight portion of the curve is the desirable operating point for amplifiers, and the lower bend the point at which detector tubes should be operated.) It should also be noted from the curves shown in figure 8, that increasing the plate voltage will require a new grid voltage value to give the same current as before the increase.

### Tube Constants

Vacuum tubes have three constants which are used to describe their characteristics. These are—*the amplification factor*, the *plate resistance*, and the *mutual conductance*.

The *amplification factor* defines the ability of a tube to amplify or increase voltages applied to the control grid. For example, a tube having a theoretical amplification factor of 5 would be one in which a voltage of one volt applied to the grid would cause a 5 volt change in the plate circuit. The amplification factor can be determined from the plate current-plate voltage curves of figure 7 by noting the amount the plate current changes for a given change in plate voltage and converting this change into terms of milliampere change per volt, and then determining the "milliampere change per volt" for a change in grid voltage. The quotient of the change per volt due to the change in plate voltage divided into

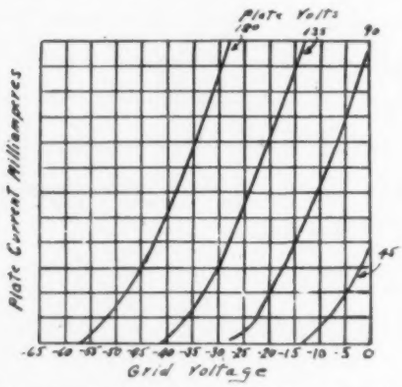



*Fig. 8.—Grid voltage. Plate current characteristic curve for Type 220 tube. (Three element tube.)*

the change per volt due to grid potential is the amplification factor.

For example, from the —22.5 volt curve (Fig. 7) we see that changing the plate voltage from 120 volts to 160 volts (a 40 volt change) causes a change in plate current of 6.50 milliamperes or a change of $\frac{6.5}{40} = .162$ milliampere per volt. We can also see that a change of 10 volts in the grid potential will change the plate current 5.2 milliamperes or a change of $\frac{5.2}{10} = .52$ milliamperes per volt.

The amplification factor is therefore the change in milliamperes per volt due to grid change (.52 milliampere per volt) divided by the change in milliamperes per volt due to plate change (.16 milliamperes per volt), or $\frac{.52}{.16} = 3.25$ amplification factor.

The amplification factor may be set up in equation form in two ways, viz.:

$$\text{A. F.} = \frac{\text{Ability of grid potentials to change plate current}}{\text{Ability of plate potentials to change plate current}}$$

$$\text{A. F.} = \frac{\text{Plate potential change required to set up a plate current change}}{\text{Grid potential change required to set up the same current change}}$$

The amplification factor of a tube is governed by the proximity of the control grid to the filament, and increases as the grid is moved toward the filament.

### Plate Resistance

The second important tube constant is the *"plate resistance."* The plate resistance of a vacuum tube is the impedance offered to the flow of alternating currents in the plate circuit and it may be determined for any value of grid and plate potential by dividing a change in plate voltage by the corresponding change in plate current for a given grid potential. For instance, in the previous example we found from our curves that a change in plate voltage from 120 to 160 volts caused a change in plate current of .0065 milliamperes.

Therefore this particular tube would have a plate resistance of 40/.0065 = 6150 ohms under the conditions given.

A knowledge of the plate resistance of a tube is essential when working with tube circuits as the impedance of the winding or resistance into which the plate circuit will work *must match the internal plate resistance of the tube for maximum power output.*

### Mutual Conductance

The third tube constant is *"mutual conductance."* This constant is the real figure of merit of a tube as it takes into account both the amplification factor and plate resistance of the tube. The mutual conductance is really a measure of the effect of grid potential changes on plate current. It is equal to the amplification factor divided by the plate resistance, i. e.,

$$G = \frac{M}{R} \text{ where}$$

G = mutual conductance;
M = amplification factor;
R = plate resistance.

The mutual conductance can be determined by the following relation:

$$G = \frac{\text{plate current change}}{\text{grid voltage change}}$$

It is apparent from an inspection of this last equation that mutual conductance (as the name implies must be in terms of mhos and such is the case). For example:

If a grid potential change of 2 volts causes a plate current change of 2 milliamperes, then the mutual conductance of the tube would be $G = \frac{.002}{2} = .001$ mhos or 1,000 micromhos.

In comparing tubes of the same type the mutual conductance factor offers the best means of comparison as both the amplification factor and the plate resistance is taken into account, i. e., a tube having a high amplification factor with a low impedance would be the best tube.

Future articles in this series will describe practical testing equipment for the small exchange which can be improvised by using the vacuum tubes.

## RESISTANCE MEASURING INSTRUMENTS FOR TELEPHONE TESTING

(*Continued from page* 34.)

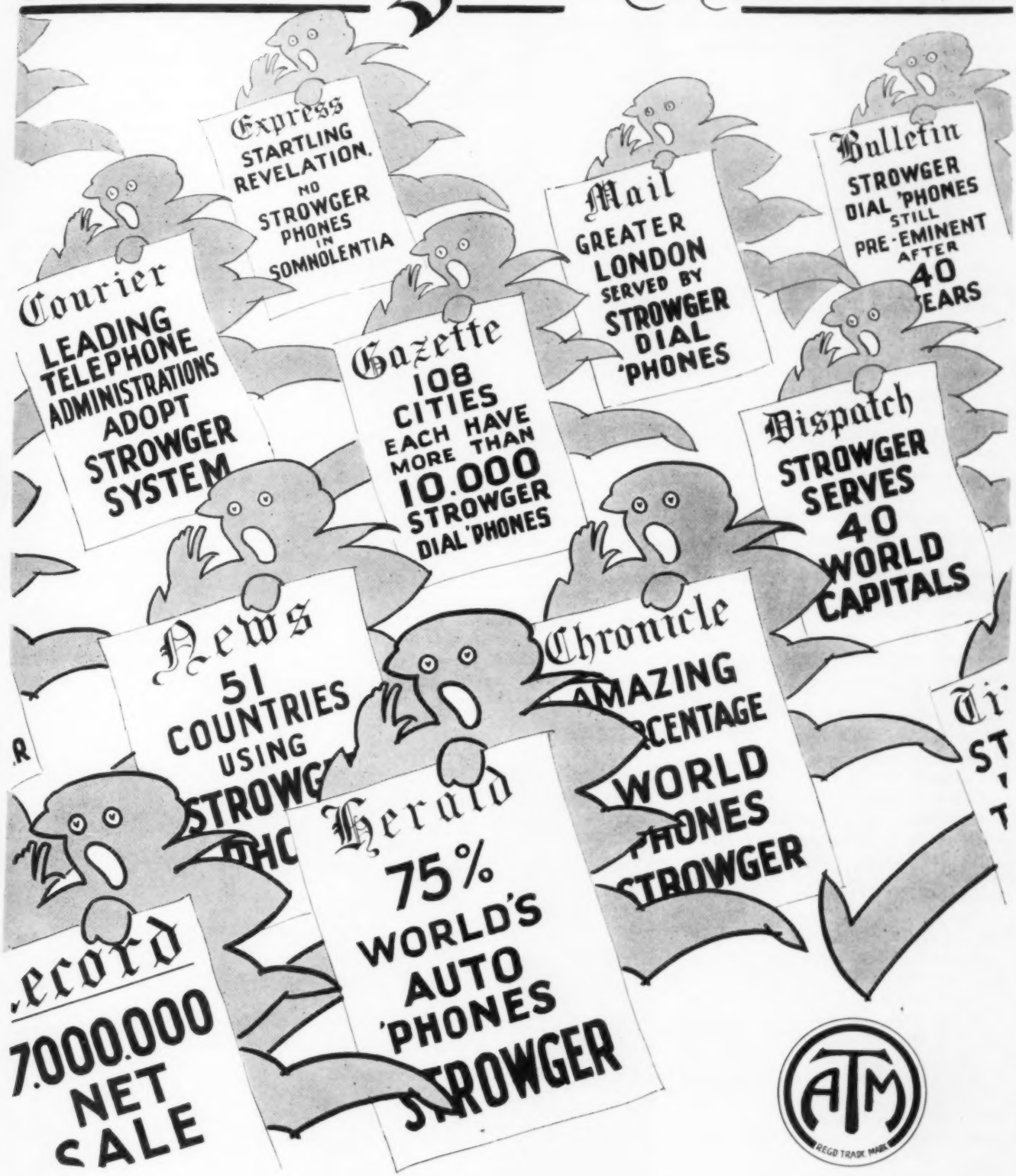
| *Condition of Subset* | *Circuit Tester Should Read* |
|---|---|
| Receiver on hook | Resistance of bells (usually 1600 ohms) |
| Receiver off hook | Between 90 to 120 ohms |
| (No condenser) | |
| Receiver on hook | Resistance of bells (around 1600 ohms) |
| Receiver off hook | About 300 ohms |
| (Condenser) | |
| Generator shunt spring closed | |
| Bells disconnected with receiver on hook. | Zero. |

Faults such as shorted condensers, high resistance switch hook contacts, failure of generator spring to open, and shorted windings are readily picked up by the above tests. Trouble location is facilitated by leaving the meter connected and noting the effect of opening various parts of the circuit thought to be at fault.

Noisy cords are quickly located by connecting the tester to the receiver terminals and shaking the cord. Cutouts will be indicated by the fluctuations of the needle.

(*Continued on page* 40)

# Strowger News




**Automatic Telephone Manufacturing Co.**
**Strowger Works, Liverpool, England**
**ASSOCIATED COMPANY**
**International Automatic Telephone Co., Ltd., London**

# Advantages of Improved Equipment

**[R. L. Thomas of Kellogg Switchboard & Supply Co., Writes of Service That Obtained Fifty Per Cent Installation.]**

It was in March, 1905, that the Cedar County Farmers' Telephone Company was organized with 200 subscribers. In 1924 a 450 Kellogg B. L. board was sufficient to handle all traffic. Today a three position, six panel Kellogg board is serving the company's 805 subscribers with service equal to, or better than, that found in the larger cities.

The Cedar County company is located at Hartington, Neb., county seat and center of a rich agricultural district of some 1,600 population. The 805 subscribers out of a total population of 1,600 is a splendid showing, a saturation of more than 50 per cent.

It is to B. Ready, president; Charles Samuelson, vice-president; Otto Emerson, manager and secretary; E. L. McGregor and A. Lammers, directors, that the company owes its phenomenal success.

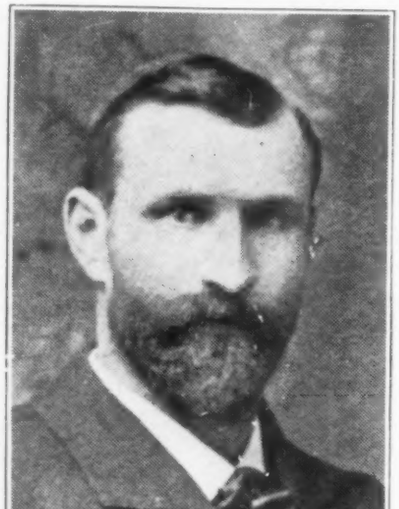
The switchboard recently installed by J. E. Wright of the Kellogg Switchboard and Supply Company is a three-position, six-panel common battery multiple switchboard. This switchboard is arranged for an ultimate capacity of 1,200 common battery local lines, wired and equipped at present as follows:

| | Wired | Equipped |
|---|---|---|
| Common battery local lines | 600 | 500 |
| Magneto toll lines | 10 | 10 |
| Magneto rural lines | 50 | 40 |
| Operators' positions | 3 | 3 |
| Local operator | 1 | 1 |
| Local and rural operator | 1 | 1 |
| Combined local, toll and rural operator | 1 | 1 |

Position number one will handle local calls, position number two, local and rural, and position number three will handle local, toll, and rural service combined.

The automatic ringing feature, faster service, better transmission, and other advantages of the new equipment have been accepted with considerable praise and comment by all subscribers. The new type desk and wall telephones are replacing the old telephones as quickly as possible.

Another example of the company's constant effort to increase their customers' good-will and to give them modern service surpassed by none is the installation of the new cradle type telephone "Masterphone" where it is desired. The first of these better telephones was installed in the court-room where it is proving to be a real salesman for the company because of its up-to-date appearance, its fine transmission, and the convenience with which it can be used.



*Otto Emerson, manager, Cedar County Co., Hartington, Nebr.*

It is through the efforts of Mr. Emerson and his associates, who strive to give their community the finest service possible, that the Cedar County Farmers' Telephone Company has grown to its present size with good prospects of continuing its past success and growth. If any one has ever had any doubt as to whether up-to-date equipment incorporating the newest developments is a thoroughly sound investment to make, here is sterling proof of its wisdom from a "better service" as well as a monetary viewpoint.

## RESISTANCE MEASURING INSTRUMENTS FOR TELEPHONE TESTING

(*Continued from page 38*)

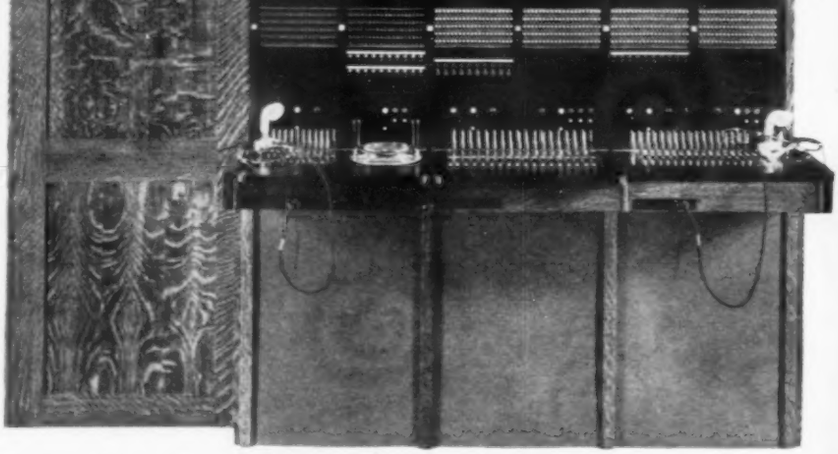
*Switchboard Testing.*—The tester is very convenient in running down cord trouble, circuit opens, grounds, crosses, key trouble, etc., in telephone switchboards.

*Miscellaneous Testing.*—In addition to the tests described, there is a multiplicity of other uses for a *circuit tester* around a telephone plant, which make it the handiest piece of testing equipment a telephone man can carry. As one troubleman said, "If I had to choose between my *circuit tester* and my portable telephone, I would take the tester."

It is the writer's firm conviction that the *circuit tester* will pay for itself twice over in a few months, as a result of time and traveling expense saved. I am convinced that it is a device which both small and large companies can profitably utilize as a standard item in the kit of every troubleman, especially those caring for rural circuits. A few months of use will convince anyone that it is just as essential as a pair of long nose pliers.

## BUYS TELEPHONE COMPANY

Purchase of the Farmers Union Telephone Company of Winnetoon was announced by the Western Telephone Corporation, of Salina, Kan.



*The new Masterbuilt line full-feature switchboard exhibited at the last national convention. The board was wired and working to illustrate its many advantages under actual conditions.*

# ANSWERING the DEMAND for Better Magneto Service

*"There Is Nothing Finer than a Stromberg-Carlson"*

**IN these modern times, the rural dweller is in such close touch with his city brother that he demands the same conveniences. He demands just as much of his telephone as any other business man.**

**Operating companies using Stromberg-Carlson 105 Magneto Switchboards and 896 Magneto Telephones find that they are in an enviable position to answer this demand.**

**The multi-faced drop shutters used on Stromberg-Carlson 105 Magneto Switchboards stand out prominently against the black background, visible from any angle, assuring the subscriber of a quick response from the operator. Double supervisory signals are placed on the keyboard in front of the cord where the operator has an unobstructed view, eliminating the chances of pulling down a wrong connection.**

**The ease with which the subscriber secures the attention of the operator and the transmission and signalling efficiency of the Stromberg-Carlson 896 Magneto Telephone win his approval. A turn of the generator crank and an unmistakable signal is registered before the operator.**

**There are many points that make Stromberg-Carlson Magneto Switchboards and Telephones winners of friendship in rural communities. Let us send you a bulletin illustrating and describing them all.**

*Write for Bulletin 114-118*

**Stromberg-Carlson Telephone Mfg. Co.**

*Pacific Coast Representative*
Garnett, Young & Co.,
San Francisco, Cal.
Los Angeles, Cal.
Portland, Ore.
Seattle, Wash.

*Factory and General Offices:*
100 CARLSON ROAD, ROCHESTER, N. Y., U. S. A.

*Branch Offices:*
CHICAGO, ILLINOIS KANSAS CITY, MO. TORONTO, CANADA

*Southern Representative*
Scoville Mercantile
Company,
Atlanta, Ga.

# Stromberg-Carlson

# THE TECHNICAL CLEARING HOUSE

B. C. BURDEN, Editor

Q.—We are experiencing considerable power noise on a grounded rural line which parallels a 3,000 volt line for one mile. Will merely making the grounded line metallic reduce the noise to a negligible amount?

A.—The induced power noise would be much less with a metallic than with a grounded telephone line and for the length parallel involved would undoubtedly reduce the noise to a small value. For best result, if the power line is untransposed through the mile, the telephone line should be transposed at the mid point of the parallel.

**Buried Cable**

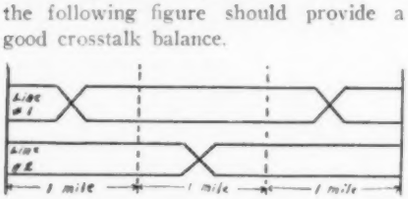
Q.—Is buried cable a practical method and if so what practice would you recommend for placing cable directly in the earth?

A.—It is generally agreed that buried cable is practicable where the cable is completely encased in a substantial coating of asphaltic compound. Experience of many companies indicates that the practice of burying cable directly in the soil without compound protection is very risky and uncertain. The chemical make-up of the soil determines the degree of corrosion to which the cable sheath may be subjected if unprotected.

**Crosstalk**

Q.—What simple transposition scheme can be used to transpose two rural metallic circuits so as to avoid crosstalk between them?

A—A transposition placed alternately in first one and then the other circuit at the mid point of each mile as shown in the following figure should provide a good crosstalk balance.




**Transmitter Test**

Q.—What simple test can be applied to a magneto subset to determine if the transmitter is operating properly?

A.—The sensitivity of a transmitter can be determined by shorting the line terminals of the set, and then blowing or tapping on the mouthpiece while noting the side tone in the receiver. A good transmitter will sound alive and a poor one will "come up" dead. Shorting the line terminals permits the entire output to pass through the receiver.

**Electrolysis**

Q.—Is there any danger from electrolysis in a town having only alternating current power distribution systems?

A.—Ordinarily there is not, however, sheath corrosion on underground cables may take place, and will resemble the effect of direct current electrolysis. Such action is due to chemical action of certain soils on the lead sheath. This condition may occur in a moist duct as well as on buried cable. Cases have also occurred where cable sheaths have been badly corroded due to differences of potential set up in the cable sheath as a result of galvanic action.

**Lightning Protection**

Q.—What is the minimum length of open wire lines feeding into unprotected cable terminals which should require lightning protection?

A.—This will vary depending on the degree of exposure. In general, lightning effects are more severe in areas not surrounded by trees or buildings. A safe rule to follow would be to place arrestors on all circuits ¼ mile or longer. Where less than four lines entering a cable are to be protected, it is usually more economical to use a separate pole type arrestor (capacity five lines) than to use a protected terminal.

**Cable Tone Test Set**

Q.—What is the schematic diagram of a cable splicer's tone test set for use in identifying cable pairs?

A.—The following diagram illustrates one form of tone test set which is suitable for cable splicing work.

**Transmitted Resistance**

Q.—What is the average resistance of typical common battery transmitters?

A.—The resistance of common battery transmitters is generally assumed to be about 50 ohms (average). The larger companies when desiring to simulate the effect of a transmitter in a subset in connection with certain tests, usually use a 50 ohm non-inductive resistance.

**High Impedance Ringers**

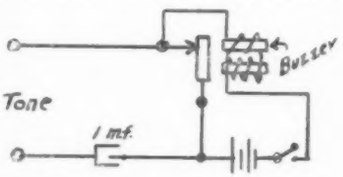
Q.—Where are high impedance substation ringers used and for what purpose?

A.—High impedance ringers are used on telephone lines which have divided ringing (ringing to ground), and which are involved in severe power parallels which would create considerable noise in the telephone circuits if ordinary low impedance ringers were used. The high impedance ringers have a great many more turns of wire than ordinary ringers, hence offer a much higher impedance to noise currents than do ordinary ringers.

**Multi-party Rural Lines**

Q.—What is the best practice with regard to the maximum number of subscribers that should be placed on multi-party rural lines?

A.—Best present-day practice indicates that no more than ten, and preferably




eight subscribers should be grouped on one line.

**Transposition Fixtures**

Q.—What type of transposition fixtures should be used in transposing rural or short toll lines?

A.—A nine inch wood pin used with a two piece transposition glass is considered suitable for transposition points in non-phantom rural or minor toll lines.

**Life of Treated Poles**

Q.—What is the estimated life of creosoted yellow pine and butt treated cedar poles, where the best grade of treatment is used?

A.—It is generally agreed that poles of this type will have an effective life of from 30 to 35 years.

**Transpositions in Power Lines**

Q.—Should power companies be requested to transpose their conductors (on new construction) in the sections which do not parallel telephone lines?

A.—Yes, they should be requested to transpose all three phase lines which they propose to construct, outside of the parallel as well as through the parallel. Unless this is done a capacitance unbalance between power conductors and ground will be created on the entire network to which the three phase line is metallically connected. Such unbalance may cause serious inductive interference in paralleling telephone circuits. Single phase lines having conductors located in a horizontal plane (on two pin crossarms) are inherently balanced to ground and will not require transposing outside of parallels. Either a three or a six mile power barrel is suitable for balancing power lines outside of parallels.

NOTHING succeeds like success. The remarkable results obtained with the Monophone in the past few years make it the logical choice as a leader for better telephone business in 1931.

The attraction that the Monophone holds for subscribers makes it possible for the telephone manager to utilize the interest in these instruments to gain new subscribers—to increase the use of extension service—to build good will—or to focus attention on any service which the telephone company has to sell.

To assist telephone companies in making vigorous and consistent campaigns for better business, American Electric is prepared to furnish (without charge) Monophone advertising material for both newspaper advertising and for enclosing with monthly bills. Samples of advertising material, together with Bulletin 100 (which illustrates and describes all types of Monophones) will be sent upon request. Write for them.

**American Electric Company, Inc.**

STATE AND 64th STREETS, CHICAGO, U. S. A.

*Branch Office and Warehouse* — 7th and Wyandotte Sts., Kansas City, Mo.
*General Export Distributors* — The Automatic Electric Company, Ltd., Chicago
*Associated Company* — Automatic Electric Inc., Chicago
*West Coast Distributors* — Sierra Equipment Corporation, Los Angeles, Cal.

# Engineering Triumph Occurs at Indianapolis

**Move Eight-Story Telephone Exchange Building Fifty-Two Feet Without Interrupting Either Telephone or Building Service; Five Hundred Long Distance Telephone Circuits in Use; Every Detail Cared for Before Actual Job of Moving Was Started.**

Once it was headline stuff when a tall building was moved around the corner without as much as upsetting the furniture. And once it was a great accomplishment when a telephone exchange was cutover to new equipment with no interruption to the service. Now, in this age of miracles, there is nothing startling about either of these engineering feats.

However, the sophisticated citizenry did sit up and gasp a bit recently when engineers in Indianapolis, Ind., moved an eight-story building housing the long-distance telephone exchange, fifty-two feet, without a single interruption in either the building or telephone service.

Business was carried on as usual within the 22,000,000 pound brick structure as it was swung around into its new position, without a hitch in the process.

More than five hundred long distance telephone circuits were in use throughout the move. This was made possible by putting into place seven submarine type cables and splicing them to all cables entering the building. Each of the new cables contained more than two hundred feet of slack which was sufficient to allow for the movement of the building. The submarine cables used were those which guaranteed the greatest possible protection to the vital telephone circuits. Armored with heavy steel wire on the outside and two layers of jute cord with a sheath of lead beneath, the cables were 3⅝ inches in diameter.

*General office building, Indiana Bell. This picture was taken after the building was moved fifty-two feet to the south, but before it was turned around.*

*Eighteen men moving over 11,000 tons. The flexible connections shown are for various services—gas, water, sewerage and steam heat.*

The more than six hundred employes seemed unaware that the building in which they were working was in motion. For the first few days it was a novelty. But after that the employes went about their work as usual while the building slowly was rolled into place.

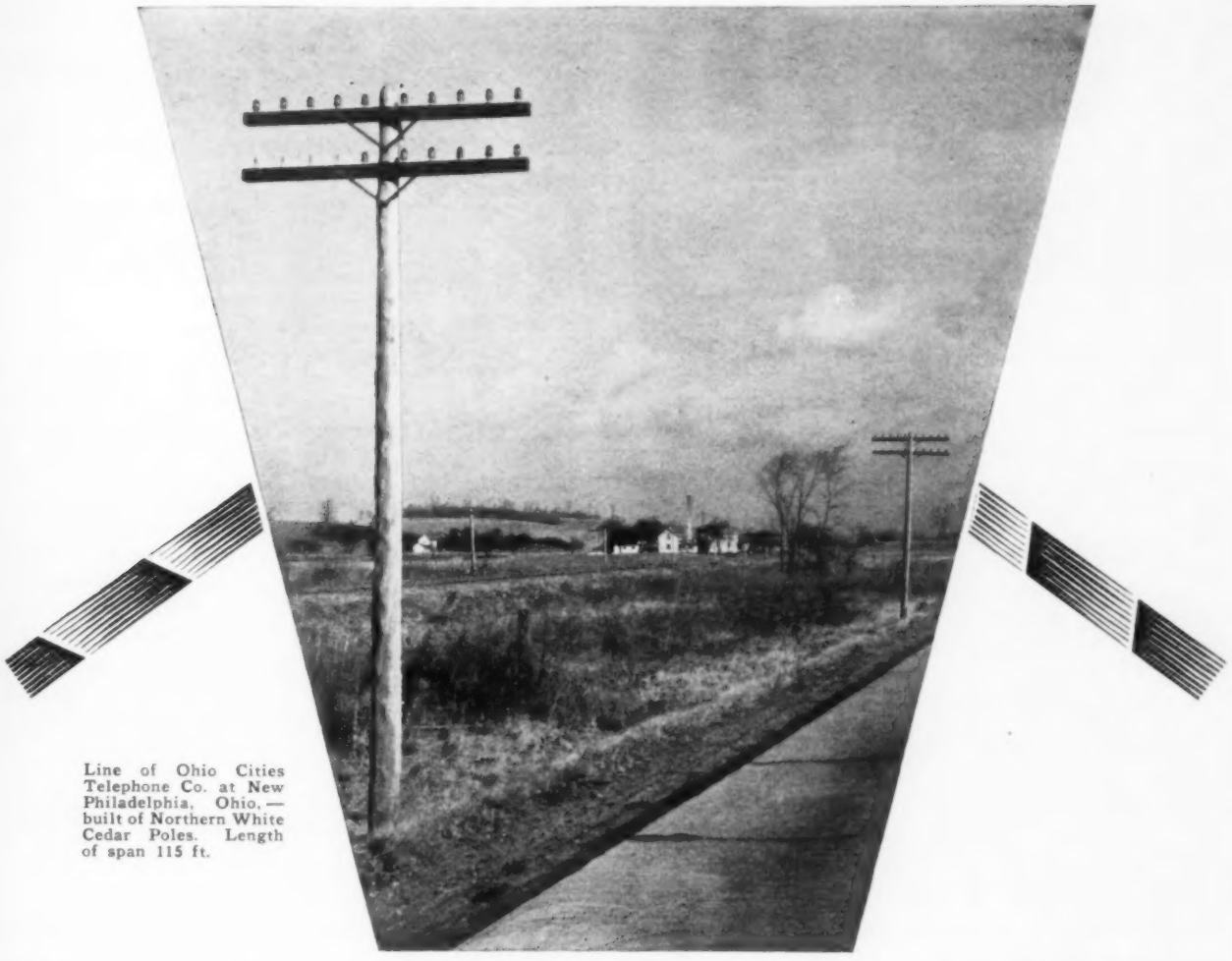
Gas, water, heat and sewage connections were made with flexible hose at the first floor level. These connections were lengthened as the structure was moved. Electrical power service was arranged overhead and anchored at the second floor.

In order that the public might be permitted to enter the building to transact business, elaborate arrangements were made. A curved steel and concrete sidewalk was constructed, and connected to the main entrance by a "draw-bridge" affair which pivoted as the building moved.

After all preparations had been completed, the moving itself assumed the proportions of a big job. The "big push" on the first move was accomplished by eighteen 100-ton and 75-ton ratchet screw jacks placed laterally and operated by one man at each jack. The speed at which the building was moved was approximately one foot an hour.

After the building had been moved to the farthest point south, the jacks were placed under each column to relieve the pressure and the position of the rollers and steel rail shoes were changed so that the rollers pointed toward the pivotal point near the southwest corner of the building. In other words, the rollers were placed at right angles to the direction in which the structure was to be moved.

The actual rolling was accomplished with jacks placed laterally at strategic points, aided by a pulling force supplied



Line of Ohio Cities Telephone Co. at New Philadelphia, Ohio,—built of Northern White Cedar Poles. Length of span 115 ft.

# The Overwhelming Choice of the Telephone Field

Notice the preponderance of telephone lines that are supported by Northern White Cedar Poles. The reason is quickly evident when you study the characteristics of Northern White Cedar:—

Stocky butts for firm anchorage, light weight for easy handling, great strength because of the large diameter where strain is greatest, long-lived because of its natural resistance to decay. You can cut gains and put on new cross arms at any time without exposing pole to decay. The time-tested pole that meets modern needs. There is an abundant supply available.

## NORTHERN WHITE CEDAR ASSOCIATION

MINNEAPOLIS, MINNESOTA

# Northern White Cedar Poles

## AUTOMATIC TELEPHONES POPULAR WITH BRITISH SERVICE

More than one-fifth of the telephone stations in the British Post Office system, 430,700 out of 1,911,800, were of the automatic type at the end of June. In London 168,000 out of 686,000 stations were converted at that date, and the process has been progressing steadily.

Of the larger cities in the country, Leeds, Sheffield, Edinburgh, and part of Manchester are working on the dial system, while of the towns with from 200,000 to 400,000 population, Bristol, Nottingham, Portsmouth, Stoke-on-Trent and Leicester are so working, and Newcastle-on-Tyne soon will be added to their number.

The automatic system is used in the following towns with 100,000 to 200,000 inhabitants: Southampton, Brighton, Middlesborough, Dundee, Coventry, Blackburn, Burnley, Swansea, Southend-on-Sea, and Stockport, while smaller towns using it include:

Bath, Bedford, Blackpool, Chatham, Colchester, Cheltenham, Darlington, Exeter, Gloucester, Hartlepool, Halifax, Maidstone, Ipswich, Newport (Mon.), Oxford, Paisley, Rochdale, Southport, Walsall, Dudley, and York. There are, in addition, about 150 rural exchanges of the automatic type, serving some 2,500 subscribers; they increased by 22 during September.

The total number of telephone stations in the Post Office system on August 31, 1930, was 1,923,406, a net increase of 7,348 on the total at the end of the previous month. Of that total, 690,400 (an increase of 2,070) were in London and 1,233,006 (an increase of 5,278) were in the provinces. Residential subscribers numbered 171,826 (increase 863) in London, and 268,058 (increase 1,472) in the provinces. Call office stations, including kiosks, increased in London by 64 to a total of 6,333, and in the provinces by 84 to 6,925.

The total number of inland trunk calls dealt with in June, 1930 (the latest statistics available) was 10,116,181, an increase of 446,512 over June, 1929. Outgoing international calls numbered 44,076 and incoming international calls 47,157, increases of 1,126 and 871, respectively, over June, 1929.

## PAY EXTRA DIVIDENDS IN 1930

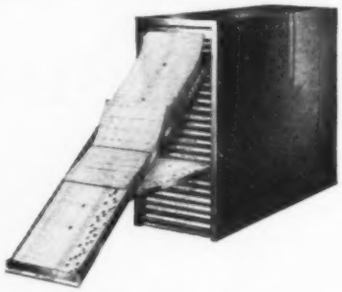
Regular quarterly dividends of $1.62½ on preferred and $0.25 on common stock recently were declared by directors of the Stromberg-Carlson Telephone Mfg. Co. of Rochester, N. Y. This made a total of four regular dividends and three extras paid during 1930, which was one more than the preceding year and two more than in 1927 and 1928.

## NEW LINE OF VISIBLE RECORDS ADDED

A new line of visible records to be known as Insite Record Products will shortly be introduced by the Acme Card System Company, 8 South Michigan Avenue, Chicago.

The line consists of Insite Card Record Products, involving the use of a standard card or folding sheet, and also Insite Listing Products, which provide for separated slips being placed in transparent tubes and filed in trays, or for the individual flexible index strips known as Flexoline.

Insite Record Products answer a need for visualization of many types of records to which existing equipment could not be effectively or profitably applied. They will be used advantageously by small business organizations as well as large ones. They can be profitably applied by every business to that business' less active but no less important records which are now maintained expensively and non-productively in vertical box files and loose-leaf books.



*New Insite Cabinet*

The name "Insite" has been given to these new records because they bring to light all the vital facts, wherever they are used, and give executives an insight into their businesses, enabling them to analyze conditions and direct activities most effectively and profitably.

Insite Card Record Products visualize and make profitable many records which have heretofore been only an expense. A few specific instances where these products can be used most effectively are on application records, appointment records, bank signature records, credit records and C. O. D. accounts, discount records, employment records, equipment records, pricing records, purchasing records, executive personal data records, and many others.

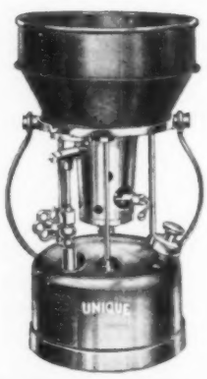
Insite Listing Products provide convenient cabinet form for many one-line or reference records which in the past have been used almost entirely on swinging frames. The tray form invites use and prompt action, and the cabinet, with its fire door, provides protection for these valuable records which they did not formerly have. A few of the many uses for Insite Listing Products are on order tracing records, customers' indexes, bin indexes to stock, rate and route records, mailing list records, telephone list records, and order and production records, over 250 different forms covering all phases of the telephone business.

Insite Record Products were developed by one of the pioneer minds in the visible equipment industry and are brought out by a company with sixteen years' experience in the profitable visualization of business records. It is regarded as the most important contribution to this field in years.

by a stationary steam engine and tackle blocks using stranded steel cables. The turning of the structure was determined by the correct placing of the jacks and rollers.

The job itself appeared comparatively simple to the onlooker. That was because every detail had been worked out completely and correctly on paper before the first steps were taken toward the actual undertaking. The plans were made mathematically and scientifically, resulting in a smooth operation of the actual process.

Furnaces **UNIQUE** Torches



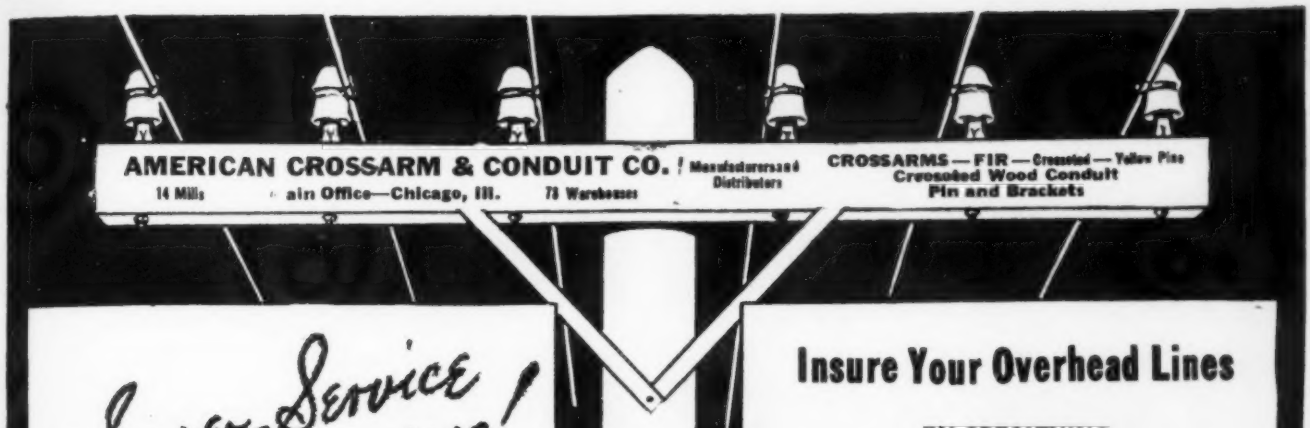

**DEPENDABLE**

**BUILT FOR CABLE SPLICERS**

A fine tool for an exacting job, with a reputation for long and trouble-free life!

*Sent on Trial*

**UNIQUE MFG. CO., INC.**
221 WHITING ST. CHICAGO, ILL.




*Super-Service on rush orders!*

If you are in a hurry your order can be loaded and on the way the same day we receive it. Quality poles since 1882 assures you of guaranteed stock and satisfactory dealings. Let us quote you prices.

Northern and Western Cedar
With or without butt treatment

NAUGLE POLE & TIE COMPANY
59 East Madison Street, Chicago
Branches: New York, Columbus, Kansas City, Spokane, Los Angeles, Boston, Madison.
Main Yards and Butt-treatment Plants: Minneapolis, Pinconning, Michigan, Spokane, Sand Point, Idaho, Seattle, Arrowhead, B. C.

**Naugle Poles**

**Insure Your Overhead Lines**

BY SPECIFYING

**MacGillis**

NORTHERN or WESTERN

**CEDAR POLES**

PLAIN or BUTT-TREATED
FROM

**MacGillis & Gibbs Co.**
120 E. Wisconsin Avenue
MILWAUKEE - WISCONSIN

**YOU CAN BUY POLES**

From Advertisers in this Publication with assurance they meet with specifications.

**Cedar Poles**

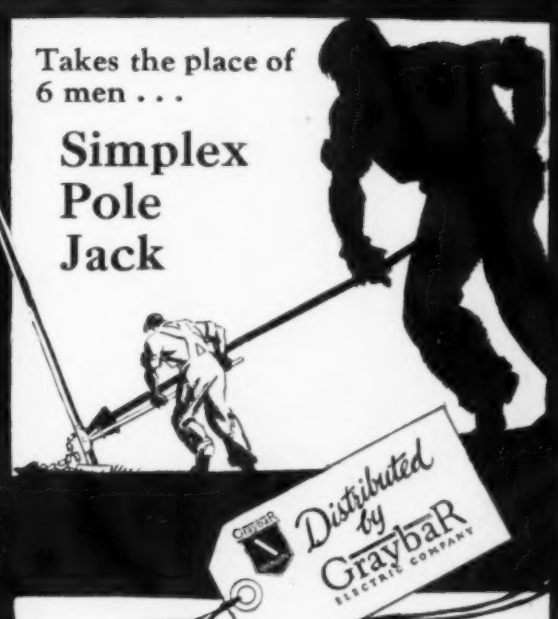
Northern White Western Red
Plain or Treated Butts

*Prompt Shipment from Minneapolis Yard.*

**T. M. Partridge Lumber Co.**
Minneapolis, Minn.

Takes the place of 6 men . . .

**Simplex Pole Jack**




Templeton, Kenly & Co., Ltd.
*Sole Manufacturers*
Established 1899 Chicago, Ill., U. S. A.
Foreign Distributors:
International Standard Electric Corporation
Northern Electric Company, Ltd.

# Telephone Activities Abroad

**Dispatches from Foreign Countries Keep United States Telephone Men Informed Concerning Telephony of the World**

### Direct Radio Service Between U. S. and China

China and the United States were linked in direct radio telegraph communication December 6, when R. C. A. Communications, Inc., opened a new circuit between San Francisco and Shanghai.

The new circuit is one of the largest in the word-wide network of radio links which now connect the United States with more than thirty countries in Europe, Asia, Africa, South and Central America. It is 6,121 miles from the transmitting station near San Francisco to Shanghai. The longest circuit from the United States is that from San Francisco to Batavia, Java, a distance of 8,646 miles. The full rate from San Francisco to Hongkong and Shanghai is $0.75 per word.

### Canadian Firm Awarded Telephone Contract

The contract for the automatic telephone equipment for the new Manitoba telephone system building in Winnipeg, Canada, has been awarded to Siemans Brothers (Canada), Ltd., for the sum of $325,788. The announcement to this effect was made by the Minister of Telephones for Manitoba on October 28. The Minister of Telephones said the equipment would cover close to 7,000 lines in the new exchange, which is expected to be ready for use by July, 1932.

### Increase Rates in Hungary

A decree by the Royal Hungarian Minister of Commerce, No. 88,968/X. 1930, published in the Official Gazette of November 8, increases inland postal, telegraph and telephone rates. The increases amount to from 20 to 30 per cent and became effective November 15, 1930.

By this decree, the cost of telephone calls is increased from the former 12 fillers less 10 per cent to 14 fillers less 5 per cent. However, the cost of installing telephone instruments is decreased from 240 pengos to 60 pengos. (One pengo, or 100 fillers, equals 17½ cents.)

### Telephone Cable Between France and England

Some technical details of the new telephone cable between France and England laid by the French Post and Telegraph authorities, are given in the October issue of the *Journal Telegraphique*.

The cable, which was manufactured by the Siemens & Halske Co., of Berlin, extends from Le Portel, near Boulogne to Seabrook, between Folkstone and Hythe. The route is longer than that of the older cables, but was adopted in order to avoid difficulties with regard to rocks and sea currents.

The length of the submarine section of the cable is nearly 47 miles; its outside diameter is 56 mm. and its weight approximately 7 tons 4 cwt. per mile; it embodies 21 double-wire circuits by means of which messages to and from England are transmitted not only to France, but also to Switzerland, Italy, Spain, and other Southern European countries.

### Link South Africa and Portuguese East Africa

Telephone communication between Johannesburg and Laurenco Marques, thus linking South Africa with Portuguese East Africa, will be established by July, 1931, according to H. G. Lenton, Postmaster General of South Africa.

### Consider Private Telephone Concern for Japan

Basic plans regarding telephone service under private management have been drafted by the Japanese Ministry of Communications and are subject to further study before final decision. The telephonic and telegraphic enterprises will be transferred to a private company but the telephone exchange business and the acceptance, dispatch and transmission of telegrams are to be handled, as now, by the Ministry of Communications, it is provided.

The plan involves an increase of about 500,000 telephones in the ten years after 1931. The present charges on telephone installations are to be discontinued, and all telephones installed free as a matter of principle. Special charges will be imposed on urgent applications for installation but these will be collected in yearly installments. The free installation system is expected to damage the present owners of telephones and telephone financiers. To protect their interest the special installation charge is adopted in the plan, which is expected to be about 100 yen ($50). The present installation charge is about 1,000 yen ($500) and the market price is nearly the same.

At first the Government intended to transfer only the telephonic business to private control but has found it advisable to transfer the telegraph service at the same time. No definite decision has, however, been reached on this point.

### First Link of Trans-Canada System

The British Columbia Telephone Co. has announced commencement of the British Columbia link of the first trans-Canada telephone system, a project which will mean the expenditure of about $1,250,000 in this province. The British Columbia section will span the province with the two new telephone circuits, requiring 655 miles of telephone line, of which 125 miles have already been erected.

The British Columbia Telephone Co. now has four construction gangs on this job, at Haney, Mission, Chilliwack and Keremeos. A fifth gang will start on the section between Hope and Othello within a week or ten days. There are also two parties of engineers out staking the route, one working between Keremeos and Thalia and one between Othello and Thalia. The importance of the new line from a Dominion standpoint can be realized from the fact that at the present time telephone calls from Vancouver to Eastern Canada have to be routed across the United States via Seattle.

### Telephone Contact Between Ships at Sea

The Post and Telegraph Office in conjunction with their radio station in Hango, Finland, have established a radio direction finding station by the aid of which the position of a ship at sea can be accurately determined, according to Commercial Attache Osborn S. Watson, Helsingfors, Finland.

The fee for using this station has been fixed at 4 gold francs or 32 finmarks (about $0.80) for each determination. The Post and Telegraph Office has also established telephone contact between ships at sea and the telephone network on land.

### Ship-to-Shore Service on Cruise

When the steamship "Belgenland" of the Red Star Line left Antwerp for New York on December 2 to begin her round-the-world cruise, her passengers were able to talk to all telephones connected by Bell System lines in the United States, Canada, Cuba and Mexico. Regular ship-to-shore telephone service linked the liner with this country while she was in the North Atlantic, and from there on as long as effective talking was found possible. Similar telephone connections were maintained with Europe through short wave radio telephone stations in England. This service is largely experimental to determine the feasibility of ship-to-shore service.

# What You Get in a Suttle Telephone

New Cabinets
Cable Wiring
Separate Terminals for ringer, transmitter, receiver
Lightning Arrester
Condenser Loop
Service Guarantee

THESE are just a few of the features offered in Suttle telephones that make them a remarkable buy for the shrewd exchange manager. The careful construction and thorough workmanship put into Suttle telephones provide years of service with a minimum of maintenance. Liberal use of terminals makes repairs or replacements extremely simple if it should be necessary. All Suttle telephones are backed by a guarantee of perfect working condition.

*See our general catalog for full description and money-saving prices.*

## Suttle Equipment Co.

Lawrenceville, Illinois

History tells us that the ancient division of the German race known as the "Easterlings" was famous for the purity of its gold and silver. Exchanged for English goods, their currency stood in such high esteem that the word *STERLING* (short for "Easterling") was adopted centuries later, as indicating the standard of value established by the British Government.

THE words "Vacuum Grip," stamped on a pair of pliers, have precisely the same meaning as the word "Sterling" stamped on a piece of silverware. Both mean "Standard."

In the telephone field the Professional Lineman pliers shown here are recognized as *standard* for design and quality. Built for heavy duty—those tough jobs of cutting, gripping, twisting and tugging that quickly wreck ordinary pliers.

Made of the strongest steel ever put into a pair of pliers, special formula electric furnace Molybdenum alloy tool steel—individually hardened by liquid heat process, tempered in oil and subjected to four separate electric tempering operations applied to the joints, cutters, gripping jaws and handles.

Hand-edged, perfectly aligned cutters that are *cutters!* Precision-built joints, combining rigidity with free movement. Long handles for powerful leverage. Perfectly balanced—not "head heavy."

VACUUM GRIP
PROFESSIONAL LINEMAN PLIERS
No. 58—8½" (Popular Size), $3.50
No. 57—7", $2.75 No. 56—6", $2.25.

PURCHASING AGENTS—
RUNNING TESTS TELL THE STORY!

*Give your linemen a few pairs of Vacuum Grip No. 58's for running tests and note their long-wearing qualities. Durability that spells a real saving for your company. When ordering write for Catalog of over 50 Vacuum Grip patterns and sizes.*

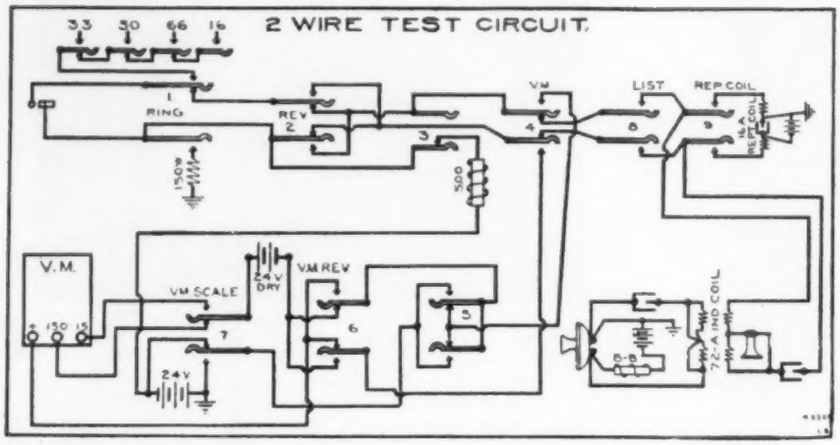
FORGED STEEL PRODUCTS CO.
Newport, Pa.

**OVER 700,000 VACUUM GRIP PLIERS IN USE**

# LINE AND DESK

## HELPFUL HINTS FROM HERE AND THERE

*TWO WIRE TEST CIRCUIT*

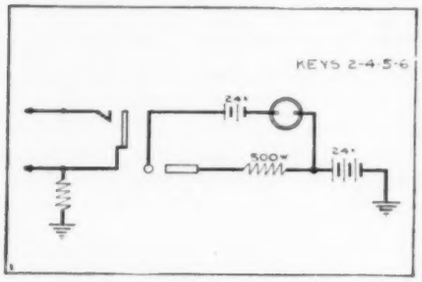



We show here a 2-wire test circuit which has many advantages in testing lines on a multiple board of that type.

This circuit enables the wire chief to obtain a "clear" test in spite of the fact that the cut-off relay is connected from the sleeve side of line to ground at all times. It helps him distinguish between a "tip" ground and a "short circuit." This test is not possible with the ordinary test circuit. It permits a clean condenser test, and has the advantage of both 24 volt and 48 volt testing batteries as well as high and low voltmeter scales.

In order to simplify the various tests, a number of drawings giving the conditions of each test and the test keys in use for each are shown.

(*Continued in next column*)

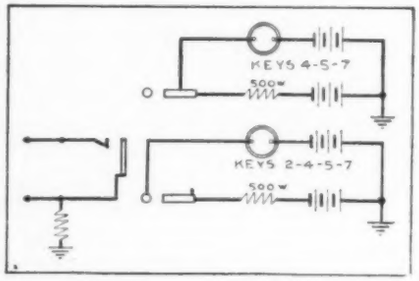



Keys 4-7—Same as 4 except low scale.

Key 4—Deflection of voltmeter indicates short circuit or loop resistance.

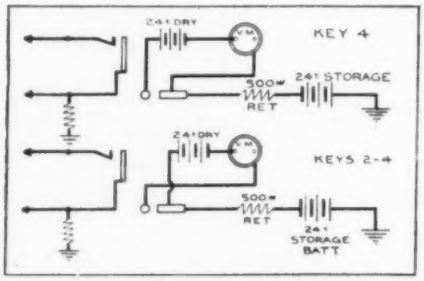
Keys 2-4-7—Same as 2-4 except low scale.

Keys 2-4—Deflection of voltmeter indicates short circuit and by operation of key 2 deflection will indicate discharge on condenser.

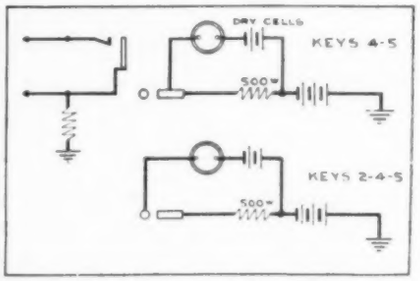



Keys 4-5—Deflection indicates sleeve ground with both dry and storage batteries in series, 48 volts.

Keys 2-4-5—Deflection indicates tip ground, with both dry and storage batteries in series, 48 volts.




Keys 2-4-5-6—Dead tip ground will give no deflection but a short circuit will show deflection of about 10. This test used to distinguish difference between tip ground and short circuit on line.




Keys 4-5-7—Deflection indicates sleeve ground with dry cells and low voltmeter scale.

Keys 2-4-5-7—Deflection indicates tip ground with dry cells and low voltmeter scale.

In this circuit key No. 3 controls the 24 volt battery through a 500 W. resistance to operate the cut-off relay on a 2-wire multiple line circuit. By operating key No. 3, the cut-off relay is released and if a subscriber is on the line, it will bring in a line signal and cause the operator to answer the call. This is a good test for "can't get central" complaints.

If you have discovered the ways and means of solving problems in your exchange, write us about it for publication. You may help some other telephone man.

---

*ELECTRICAL MEASURING INSTRUMENTS*

By A. Helper

It is generally believed that the average telephone company does not take advantage of the full use of electrical measuring instruments. Take the average telephone power board and you will find it equipped with a voltmeter and an ammeter.

In most cases the ammeter registers the charging current only when it could be doubly as useful by registering the discharge current of the telephone switchboard. The discharge meter is quite necessary and is a feature that should never be omitted on any telephone system. The discharge record can be made more useful by the installation of a recording ammeter.

Daily records need not be kept save as peg counts on average days. In fact, by taking an average of the length of conversation, as the current consumption per cord circuit is known, a study can be made from the chart of the recording ammeter which will in many cases give a more accurate record of the traffic than will the most carefully kept manual peg count.

Frequency meters to make periodic tests of the ringing machines are also a good investment. Alternating current voltmeters to test the output of the ringing machines are also quite useful. Very often troublemen are sent out on a case of bell trouble when the real fault lies with the ringing equipment causing intermittent trouble which is difficult to locate without the proper instruments.

If suitable meters are installed and records kept, valuable engineering data will be accumulated which in most cases will pay big dividends for years to come.

---

Host: "There are my grandma's ashes over there in the corner."

Guest: "Oh! So the poor soul has passed on?"

Host: "No, no! She's just too lazy to look for an ash tray."—Exchange.

## Independent Sales and Engineering Company, Limited

VANCOUVER, B. C.

THE complete stocks of telephone apparatus, construction materials and supplies carried in our Vancouver warehouses enable us to render unsurpassed service in Western Canada.

MANUFACTURERS AND DISTRIBUTORS OF

TELEPHONES, TELEPHONE APPARATUS AND MANUAL AND AUTOMATIC SWITCHBOARD EQUIPMENT

Representatives in Western Canada for

AMERICAN ELECTRIC INC., Chicago
AUTOMATIC ELECTRIC COMPANY, INC., Chicago
AUTOMATIC TELEPHONE MANUFACTURING CO., LTD., Liverpool
THE AUTOMATIC ELECTRIC COMPANY, LIMITED, Chicago

# TELEPHONE WIRES and CABLES

Electrolytic Copper Rods
Bare and Insulated Copper Wires
Switchboard Cables
Rubber Insulated Wires
Magnet Wire
Flexible Cords
Enamelled Wire
Power Cables

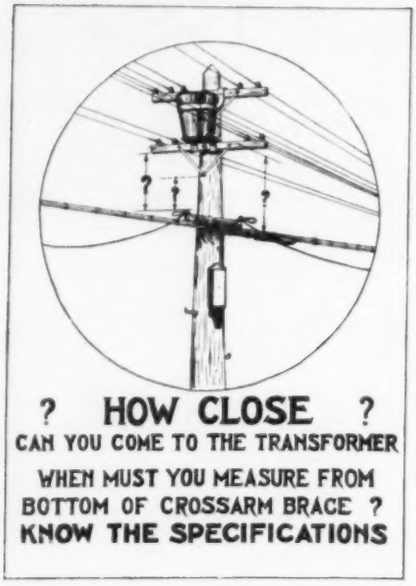
## Eugene F. Phillips Electrical Works Limited

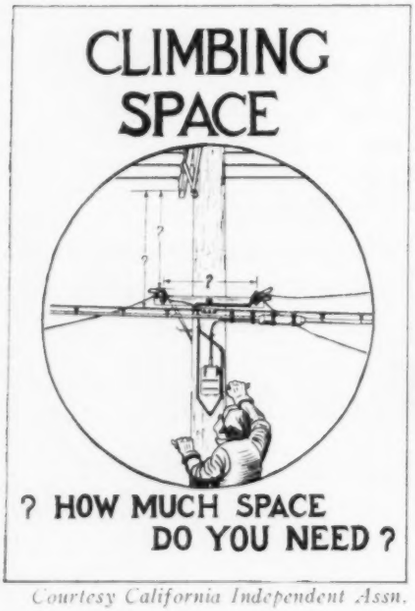
(Established 1889)

MONTREAL, CANADA

Factories---Montreal and Brockville

*DO YOU KNOW YOUR SPECIFICATIONS?*




*Courtesy California Independent Assn.*

Are you getting the correct solution to these problems? We are now showing two each month. Join this monthly game that will improve your knowledge of telephony. Look for the answers next month.

*BOLT CUTTERS*

By Ray Blain

I have never been able to understand why so few telephone companies take advantage of that simple but all important tool, the bolt cutter.

There was a time in the past when messenger strand was fairly easy to cut by makeshift means, but with recent improvements in steel and methods of manufacture the present messenger is most difficult to cut unless proper tools are provided. Just recently I watched a lineman work nearly fifteen minutes cutting a messenger strand by first filing a notch around it and then bending with a pair of connectors. Besides the time lost, the man wore himself out and ruined his disposition for the day.

With a good bolt cutter, messenger strand as large as 5/8 in. can be cut with the same ease as can a No. 12 copper wire with a good pair of 7-in. pliers. Another advantage is that the strand is cut off clean which permits easy serving of the loose end of the guy. If proper tools are not used to cut the strand the end is generally frayed and a neat serve up is impossible.

One or more pairs of good bolt cutters should be kept available in every telephone exchange for most every day in the entire year they will be used to advantage, saving time and money for the company and time and energy for the linemau.

*DO YOU KNOW YOUR SPECIFICATIONS?*

The answer to last month's problem appearing on page 32 of the November issue is:

Service drops distributed from brackets attached directly to the pole must have a clearance on service pole only of 5 feet under supply circuits of 0-750 volts.

Paired wire line extensions may be attached directly to poles by means of brackets. All such wire must be supported on one bracket and clearance under supply circuits shall be 6 feet.

Now look up this month's problem, of which there are two. This is great fun and the information may prove valuable some day.

---

Telephone Operator: "I have your party. Deposit five cents, please."

Voice from pay station: "Whazzat?"

"Please deposit your money!"

"Say, lizzen! 'Sgreat advice, of coursh. But what I want jesh now is conversatshun with m'friend, not financial counsel from a stranger."

*Front view of a portion of the Kellogg display at the U. S. Independent Telephone Association convention. Note the 1200-1600 Masterbuilt full-feature switchboard visible through the archway.*

*Front view from the left of the Kellogg exhibition. The chief displays are situated in the hall visible through the arches, behind the attractive front area.*

Note Protection at Corners

**Blake Insulated Staples**
Trade Mark

Unequalled for telephone and bell wiring. The fiber insulation prevents troublesome short circuits and grounds. 4 sizes. Pat. Nov., 1900. Write for samples.

**Blake Signal & Mfg. Co.**
BOSTON, MASS.

**"STEWART" Test Set**

Trade in your old test set on a New STEWART with Detector coil. Tells distance and direction to line trouble. Complete as shown in sketch for $36.00. Sent on trial. Write for literature.

**STEWART BROTHERS**
OTTAWA, ILLINOIS

"Cope"

Flexible Metal Tubing with Bell Shaped Ferrule and Brass Nozzle which slips into the Duct.

**Pull-in Guides for Lead Sheathed Cables**

**T. J. COPE, Inc.**
Manufacturers of
Complete Equipment for Cable Installation
6122 Vine Street, Philadelphia, Pa. 19 So. La Salle Street, Chicago, Ill.

HOTEL HARRISON

CHICAGO'S NEWEST DOWNTOWN HOTEL

RUNNING ICE WATER IN EVERY ROOM
$2.50 AND $3.00
WITH BATH
NO HIGHER

RADIO IN EVERY ROOM

NO PARKING WORRIES
DIRECT ENTRANCE FROM HOTEL TO HARRISON PARKING GARAGE

HARRISON STREET JUST OFF MICHIGAN BOULEVARD
CHICAGO

**Keeping an Eye on Millions of Dollars**

THINK of the vast sums which have been collected on toll charges since 1894, when the first Calculagraph to serve American telephone companies began its work of counting up the minutes and excess minutes on the nation's toll boards. What a keen, watchful eye the Calculagraph must have kept on these millions of dollars, to serve so long and with such complete satisfaction.

The Calculagraph stamps on the toll ticket the beginning of each call together with the time elapsing during each call, down to the quarter of a minute, for any number of calls—producing a permanent and accurate record of each.

Prices and Information on Request.

THE CALCULAGRAPH COMPANY
50 Church Street Dept. 22 New York City

CALCULAGRAPH
THE ELAPSED TIME RECORDER

## News From the Field

Work has been started on the installation of a new telephone system in Sparta, Ill. Four crews of men are at work rebuilding the system. The old system of cranking in order to call central will be replaced by modern equipment.

The Pennsylvania state police telephone-typewriter, with 106 stations installed in various towns and cities for rapid communication in the pursuit of criminals, will take on another function in the dissemination of weather facts. Bulletins on snowstorms, slippery roads and other information will be distributed by this service.

The four-hundred-thousandth telephone in Los Angeles was installed recently at the Los Angeles Coliseum. This instrument represented a growth of more than 100,000 telephones during the last four years and celebrated the 50th anniversary of the Los Angeles system.

A new Universal switchboard has been installed by the Wamego Telephone Company, Wamego, Kans., in the new company headquarters recently purchased from the Wamego State Bank. It is equipped with light signals and can be converted into a common battery system at any time.

Improvements in the Burchard and Table Rock, Neb., exchanges have been made by the Lincoln Telephone and Telegraph Company. At Burchard a new switchboard has been cut over for use in the remodeled office building, and Table Rock's improvements include extensive rebuilding of poles and lines.

Bell Telephone of Pennsylvania has been authorized to issue 200,000 shares of common stock of $100 par and to offer these shares at par to holders of common stock of record December 31, 1930.

The Rochester Telephone Company, Rochester, Ind., reports an unexpectedly large response to their offer to install telephones free. The company believes the free installation justified by depressed business conditions.

Exchanges at New Richmond, Linden and Romney, Ind., previously owned by John C. Dixon of West Lafayette, have been purchased by W. Thomas of Shirley.

Improvements estimated to cost $12,000 will be added to the exchange at Lennox, S. D. Work will begin in January, according to W. C. Martin, Lennox manager for the Central West Public Service Company.

The Wisconsin Telephone Co. is spending $108,500 on construction projects in the Milwaukee area. Installation of 26½ miles of underground cable forms the major part of the undertaking.

A new and modern telephone system has been installed by the Floresville Rural Telephone Company, Floresville, Tex. The new quarters occupied by the exchange have been completely remodeled and refinished and together with the new equipment represent an expenditure of $12,000.

The permanent transmission line has been installed across the new Market street bridge spanning the Wabash river in Logansport, Ind., by the Logansport Home Telephone Company. The lead cable, encased in the conduit line, contains approximately 800 wires serving the subscribers across the river.

New construction to cost $40,000,000 will be the 1931 contribution of the Pacific Telephone & Telegraph Company to employment in Pacific coast states, according to an announcement by President H. D. Pillsbury.

The Ashland Home Telephone Company, Ashland, Ky., has purchased the Greenup County Home Telephone Company, comprising a total of 900 telephones. The Ashland company plans extensive improvements estimated to cost $50,000.

An increase of nearly 25 per cent in the number of common stockholders of the Associated Telephone Securities Company has been recorded since January 1, 1930, according to an announcement by the company.

Directors of the Illinois Bell Telephone Company have approved expenditures of $1,795,772 for new plant and equipment in Chicago and $786,555 for Illinois, outside of Chicago, making a total of $2,582,327 approved today. Expenditures approved in 1930 amounted to $23,550,899, against $37,730,750 in 1929.

**Investigate Our Centralized Accounting Plan**

This monthly Audit will save you lots of money and give you important information that you should have about your business—the best of all business, if properly managed.

**BOWDLE ACCOUNTING SYSTEM**

CERRO GORDO ILLINOIS

**Columbia**

**Gray Label Telephone Batteries**—*they last longe*

National Carbon Co., Inc., *General Offices:* New York, N. Y.

*Branches:* Chicago Kansas City New York San Francisco

*Unit of Union Carbide* UCC *and Carbon Corporation*

**RUNZEL-LENZ ELEC. MFG. CO.**

**ESTABLISHED 1904** **CHICAGO**

**Specializing in Manufacture of**

**CORDS**

**FOR ALL CLASSES OF TELEPHONE WORK**

**SIERRE EQUIPMENT CORPORATION**

**Los Angeles—San Francisco—Seattle—Pacific Coast Distributors**

**Get EVER-PROTECT aid in your construction.**

EVER-PROTECT has proved practical and profitable in making many hundreds of cable installations underground without a conduit. It protects cable against storm damage, corrosion, chemical action, electrolysis and abrasion.

In liquid form EVER-PROTECT is great for overhead work, protecting your cable and messengers against chemical action and other destructive influences.

Ask your nearest jobber for complete details.

EVER-PROTECT CABLE COMPOUND

National Cable Compound Co.
Incorporated
MITCHELL - - IND.

To Reach the Man
Who Does the Buying
Advertise
in
TELEPHONE
ENGINEER

The ROBT·E·LEE HOTELS

ST. LOUIS AND KANSAS CITY IN MISSOURI

18th and Pine St. Opened March 1928

13th and Wyandotte In the Heart of America

SAN ANTONIO AND LAREDO IN TEXAS

A City of charm On the Old Spanish Trail

On the Rio Grande and the Mexican Border

Garage Service

Every room with private bath & ceiling fan

WE QUOTE OUR TOP PRICE $2.50

A MATTER OF ECONOMY $2.00

PERCY TYRRELL
President

FORT DEARBORN HOTEL

Announces

SENSATIONAL REDUCTIONS

$1.50 A DAY more than 250 rooms with private toilet at this rate

SPECIAL WEEK-END (Saturday & Sunday) RATES

250 rooms with private toilet for double occupancy per person... $1.00 A DAY

250 rooms with private bath for double occupancy per person... $1.50 A DAY

LA SALLE & VAN BUREN STREETS

CHICAGO

OPPOSITE LA SALLE STREET STATION

# With Manufacturers and Jobbers

## NEW TELEPHONE DEVICE AIDS DEAF

A device, known as the Audiphone, which should be of interest to telephone people, has been placed on the market. It is for use by persons who have difficulty in hearing over a telephone.

The Audiphone is strictly portable with no permanent connection to the telephone and can be used with any make desk stand. Designed primarily for

*Showing Audiphone with super-sensitive transmitter.*

telephone use, it can also be used for conversation in a room and will amplify speech at a distance of twenty-five feet.

The feature of the Audiphone is a super-sensitive transmitter designed to pick up very weak voice waves, which is accomplished by a "floating composition diaphragm." A special transformer to match the impedance of the special transmitter is used, and standard radio batteries and one tube are used for the remaining part of the set.

A regulator to control the amplification is provided and in using the set for conversation the switch button must be held "on." This is to prevent leaving the set turned on while not in use. At the present time this is the only portable amplifier set designed especially for telephone use that is available to the Independent telephone companies.

Some sets have been furnished to telephone companies equipped with a small horn which makes telephone conversations similar to listening to a radio program. This permits the use of both hands to take notes, when desirable. This additional feature is used in private offices and homes where privacy or disturbing others is not a factor. It also relieves holding the receiver to the ear during a long conversation.

The Audiphone set weighs ten pounds complete and is easily carried from one telephone to another. It is not intended for street use as a deaf set. Standard batteries are used and can be changed by anyone. The set is finished in black morocco leather. The dimensions are 8½ inches high, 5¼ inches wide, and 8 inches long.

## ELECTRIC DRILL SAVES TIME AND MONEY

A new type of electric hand drill that bores with equal facility into wood, metal and masonry is shown in the accompanying illustration. It is known as the Wodack electric dual twist and hammer drill.

This tool is considered one of the greatest developments ever made in an electric drill. It will save time, money and labor for every one whose work requires the installation of expansion bolts or the drilling of holes up to seven-eighths of an inch in stone, concrete, or brick.

The Wodack dual drill requires only one minute to drill a nine-sixteenths inch hole, three inches deep into concrete. In addition to operating as a hammer, it is a highly efficient rotary drill with correct speed and power to provide maximum drilling efficiency over the entire range of sizes to three-eighths of an inch in metal and one-half of an inch in wood.

It is also an effective tool for grinding, scratching or buffing. It thus permits the operator to sharpen tools and bits while on the job.

*Wodack Dual Drill goes through concrete like wood.*

The tool is furnished in a handsome metal carrying case with star drills and twist drills. Grinding, scratching and buffing wheels and bench stand can be secured, as well as a convenient stand for use as an auxiliary drill press or bench grinder.

The tool itself weighs only twelve pounds, and the entire kit only twenty pounds.

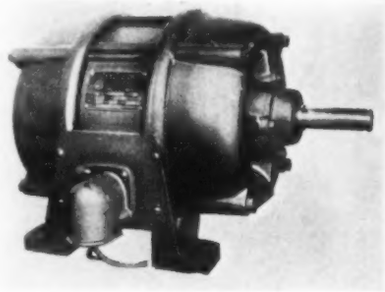
## IDEAL INTRODUCES NEW MOTOR

The Ideal Electric and Manufacturing Company of Mansfield, Ohio, has developed a complete series of electric motors that represent a radical departure from the ordinary type and design familiar to users of electrical power units. These motors may be used in many instances in connection with a telephone exchange.

In the Unit Type construction that is being announced for the first time, many new design features of considerable interest are presented.

By placing the motor feet on the baring brackets all load shocks and strains are carried directly to the motor support. Shock loads or vibration will not affect the live elements or weaken the assembly of this motor. Since the bearing brackets support themselves the only mechanical load on the stator is the motor torque.

When the front end bracket and stator



*The Ideal Motor has new valuable features.*

are removed, the pulley end bearing bracket remaining bolted to the base will still support the rotor and gear, pulley, or other connection to the driven machinery. This allows cleaning and examination in much less time than usual and without disconnecting the drive gear or pulley.

These motors are built with standardized units (rotors and stators) which are perfectly interchangeable for all types. Thus standard horizontal motors, shell type motors, flange type motors, vertical motors, special applications of "built in" motors requiring only the active elements, all take the same rotors and stators.

Interchangeable ball, roller or sleeve bearings; anti-friction bearings are supplied as standard because of their many advantages. The ball and roller bearings are of the cartridge type, so constructed that the motor can be taken down without dust or dirt entering the bearing. This assures long and continuous operation. Zerk fittings with automatic seal are used to supply grease under pressure.

The stator core is reinforced by eight steel bars (ribs) welded directly to steel rings (stator heads) at each end of the core. This forms a welded steel cage which is ground to fit the two bearing brackets—the most simple and rugged construction possible. The stator slots are skewed in relation to the rotor slots to assure quiet operation, lively acceleration, and absence of dead points on starting position. The corresponding field structure of direct current motors is sim-

# DIRECT SHIPPING ROUTES for BROWN TREATED POLES

WHEN you buy Brown treated poles of Southern Yellow Pine, you get them on time.

Storage Yards and Treating Plants at Brownville, Ala., and Louisville, Ky., ideal locations for quick deliveries of poles because of splendid rail routes diverging North, East, South and West.

And our traffic department maintains a service throughout the transit of your order which enables us to tell you where your poles are at any time.

*We frankly prefer to make contract deliveries over an extended period, but if you have an emergency put it up to us.*

**BROWN WOOD PRESERVING COMPANY**
(Formerly Creosoting Department W. P. Brown & Sons Lumber Co., Inc.)
4th and K Streets, Louisville, Kentucky
Long Distance Telephone, Magnolia 2407

**BROWN**
**CREOSOTED YELLOW PINE PRODUCTS**

**300,000 Acres One of the largest**

**Individual Holdings in America**

ilarly designed as a unit to take the standardized bearing brackets.

Insulation of motor windings is of utmost importance and has received careful attention in Ideal Unit type motors. The slot cell insulation is a tough fibrous material possessing heat resistant qualities and great dielectric strength and especially developed for this motor. The stator coils are wound with enameled wire, cotton covered. Varnished duck is used for phase insulation, an exceedingly tough material with excellent insulating properties.

The Ideal "Unit Type" motors are made as standard squirrel cage induction motors, slip ring induction motors and direct current motors in all types of mechanical construction and electrical characteristics. The squirrel cage induction motors are made in four standard designs.

FOR SALE: 5 strips Stromberg No. 11-A combined drops and jacks, $8.75 per strip of five. Excellent condition. Corwin Electric Co., Indianapolis, Ind.

Make Your Directory a Source of Income
*Write for Particulars*
**J. H. WELKER**
McKinley Block, Canton, O.
Telephone 8009
DIRECTORY ADVERTISING EXCLUSIVELY

**ACCOUNTING**
Specialization on Public Utility Accounting Records and Audits enables us to best serve Telephone Companies.
**HERDRICH AND BOGGS**
Certified Public Accountants
901-7 Continental Bank Bldg., Indianapolis, Ind.

## RECONSTRUCTED EQUIPMENT

| | |
|---|---|
| General Elec. Mercury Arc Rectifier, No. 11,139, Cat. No. 119,593, operates from either 110 or 220 Volt 60 cycle Ckt. Delivers 10 to 120 Volts D. C. Current, 10 Amps. Complete with Volt and Amp. Meters and voltage regulator and one extra Tube @ | $100.00 |
| Stromberg No. 190 type or Dean Peanut line and cut-off relays on mounting plates. Units of 50 pairs $50.00—Units of 60 pairs @ | 60.00 |
| Dean or Stromberg No. 4260 Ans. or Lamp jacks with lamps 10 per strip @ | 2.00 |
| 22 or 24 volt Swbd. Lamps, per 100 | 5.00 |
| Kellogg No. 17A repeating coils @ | 3.75 |
| Kellogg No. 28 desk sets with cast head complete with W. E. No. 240 3-bar 1000-1600 or 2500 ohm external post connection signal set @ | 8.00 |
| Kellogg No. 28 desk set with cast head complete with Stromberg 4-bar 1000-1600 ohm inside cord connection signal set @ | 8.75 |
| Kellogg No. 2696 type 4-bar 1000 or 1600 ohm Bdg. compacts @ | 8.50 |
| Western Elec. No. 240 3-bar 1000-1600 or 2500 ohm External post connection hotel set @ | 5.00 |
| Chicago Tel. 4-bar 1000 or 1600 ohm Bdg. compacts @ | 6.75 |
| Western Elec. No. 317 inside connection 3-bar 1000-1600 or 2500 ohm Bdg. compacts @ | 8.75 |
| Dean Elec. No. 240 4-bar 1000 or 1600 ohm Bdg. compacts with Kellogg Transmitters @ | 7.00 |

Write for Bulletins
REBUILT ELECTRIC EQUIPMENT CO.
1940 West 21st Str., Pilsen Station
Chicago, Ill.

## INDIANA COMMERCIAL TELEPHONE COMPANY DESIRES TO PURCHASE OTHER CONCERNS

Engineers of the state public service commission of Indiana have appraised the Home Telephone Company of Elkhart county at $1,137,238, according to a report received by City Clerk Warren Sheffer. The Home Telephone Company is actually being operated by the Indiana Commercial Telephone Company and will be taken over by that company.

Other properties which the Indiana Commercial Company have asked permission to purchase are the Logansport Home Telephone Company, the Steuben County Telephone Company, the Fayette Telephone Company, the Greencastle Telephone Company, the Liberty Telephone Company, the Royal Center Telephone Company, and the Putnam County Telephone Company.

The new appraisal made by the commission in July of this year shows an increase in valuation of $54,602 over the last appraisal made in September, 1927. Individual stockholders, many of them Goshen residents, sold 85 per cent of the common stock for $1,500,000 in May, 1928, to the Central States Telephone Company. The property has since been acquired by the Indiana Commercial Telephone Company.

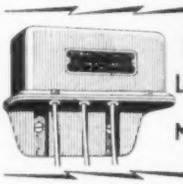
## PROPOSE DIRECT SERVICE BETWEEN CANADA AND GREAT BRITAIN

According to a Canadian Press cable from London, December 4, the British Postmaster General said in the House of Commons that Canada had requested direct telephone service with Great Britain instead of the present facilities via New York. Although the British Post Office had informed Canada that the present route provides more reliable service than the direct arrangement can be expected to furnish, the British authorities will carry out the wishes of the Dominion and the new direct service will be opened within the next few months.

## SPENDS WINTER IN FLORIDA

Mr. and Mrs. Geo. W. Rodormer and son Winston left Christmas week for Florida where they expect to spend several weeks. This is the first vacation young Rodormer has had since he became connected with the Reliable Elevtric Company and he expects to make the most of it. Winston will return in time to attend the Minnesota convention, and will leave soon aftreward for an extended business trip to the Pacific coast.

**J. G. WRAY & CO.**
Telephone Engineers
Specialists in Appraisals, Rate Surveys, Financial Investigations, Organization and Operation of Telephone Companies
J. G. Wray, Fellow A. I. E. E.
Cyrus G. Hill
Rm. 2130 Bankers Bldg., Chicago


**CHAPMAN**
LIGHTNING ARRESTERS
MADE BY
MINNESOTA ELECTRIC CO
MINNEAPOLIS, MINN.

We will sell your
**Telephone Directory ADVERTISING**
or will publish your directory complete
**L. M. BERRY & CO.** DAYTON, OHIO

Send for free sample and prices on
**UNIVERSAL DROP WIRE INSULATORS**
Universal Specialty Company
711 Poplar St., Terre Haute, Ind.

**FOR SALE**
KELLOGG COMMON BATTERY EQUIPMENT
Late type Relays, mounted 8-10-16-20 per strip @ $2.50.
Lamp Jacks, single mounting @ 10c.
24 or 48 volt Switchboard Lamps @ 11c.
No. 264 Four-Party Ringing Keys @ $2.60.
We have some odd lots of pole hardware and Cable terminals. Also Telephone Booths with folding doors. Prices and description on request.
**Telephone Repair Shop**
1760 Lunt Ave., Chicago, Ill.

**American Electric Co. Equipment**

| | |
|---|---|
| No. 50 transmitters | $ .75 |
| No. 60 receivers with new shells and caps | .75 |
| New shells and caps | .35 |
| No. 102 or 127 switch hooks | .45 |
| No. 76 ringers | 1.00 |
| ½-MF, 1-MF and 2-MF Mansbridge condensers | .50 |
| 5-C and 31-B induction coils | .50 |
| 3, 4 and 5 bar Hercules late type generators | $2.00, 2.50 and 3.00 |

**Buckeye Telephone & Supply Company**
COLUMBUS, OHIO

**Stromberg-Carlson engineers will gladly send you descriptive matter explaining why the Stromberg-Carlson Junior Multiple Switchboard is the ideal telephone switching equipment for the small exchange.**

*Write for Bulletin 135*

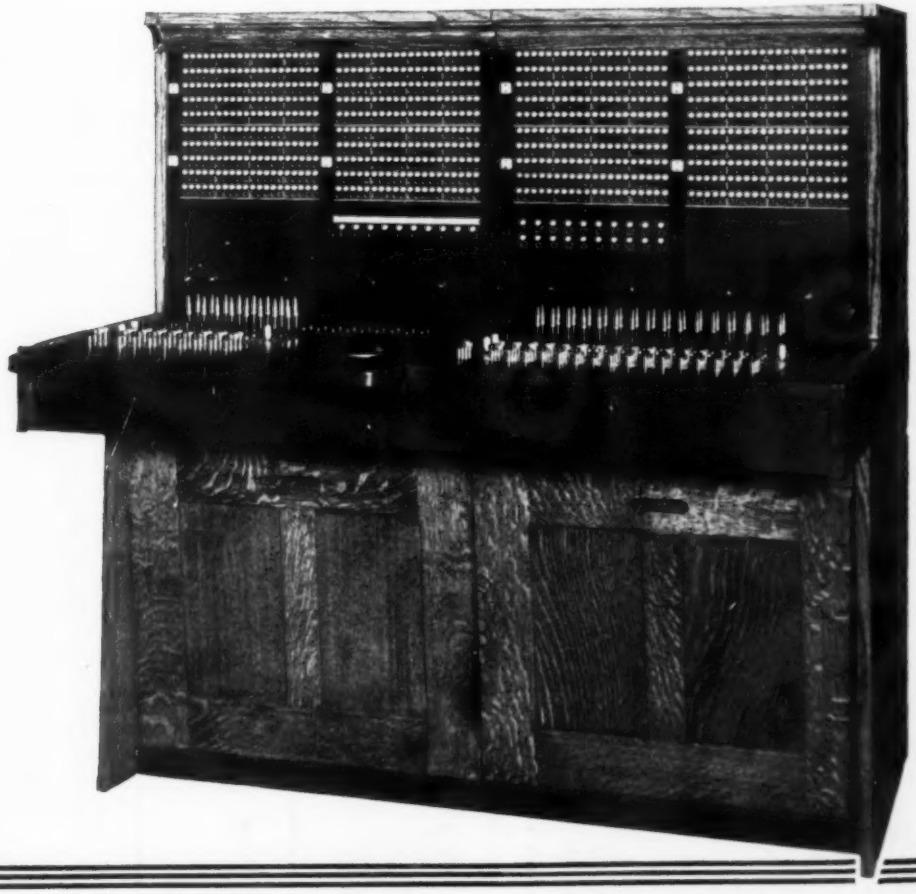
**Stromberg-Carlson Telephone Mfg. Co.**

*Factory and General Offices:*
100 CARLSON ROAD, ROCHESTER, N. Y., U. S. A.

*Branch Offices:*
CHICAGO, ILLINOIS KANSAS CITY, MISSOURI TORONTO, CANADA

*Pacific Coast Representative—*
Garnett, Young & Co., San Francisco, Cal., Los Angeles, Cal., Portland, Ore., Seattle, Wash.
*Southern Representative*—Scoville Mercantile Company, Atlanta, Ga.

*"There Is Nothing Finer Than a Stromberg-Carlson"*



# ~ Carlson

# TELEPHONE ENGINEER

192 N. Clark St., Chicago. Telephone STAte 8971

PUBLISHED MONTHLY BY

TELEPHONE ENGINEER PUBLISHING COMPANY

J. A. SMITH, 192 N. Clark St., Chicago, President and Treasurer
C. L. JONES, Athens, Ohio, Vice-President
D. WEINER, 192 N. Clark St., Chicago, Secretary
F. A. BOWDLE, Cerro Gordo, Illinois, Vice-President
HAROLD L. BEYER, Chicago, Vice President

Vol. 35 No. 2 February, 1931

SUBSCRIPTIONS:—The subscription price of TELEPHONE ENGINEER is $2.00 a year in the United States, Cuba and Mexico; in Canada it is $3; in all other countries $4. Single copies, U. S. A., 20 cents.

Entered as second-class matter, June 6, 1922, at the post office at Chicago, Ill., under the act of March 3, 1879


## Table of Contents


Editorial ..... 15-16-17

Hitting the Upgrade for Nineteen-thirty-one—Rates, Commissions, and the Public—Service Connection and Moving Fees.

Relays Involved in Incoming Trunk Circuit—by J. H. Levis, Jr. ..... 17-31

Our Engineering and Management Course—by B. C. Burden ..... 18-19-20

Convenient Methods of Drop Wire Construction—by Ray Blain ..... 21-22-23

Telephone Activities Abroad ..... 24

Open Wire Systems Simplify Broadcasting—by R. A. Leconte ..... 25-26

Simple Rules to Follow in Locating Trouble—by Ernest Wommack ..... 27

Line and Desk ..... 30-31

Practicing Economy in Carrier Operation—by F. J. Dommerque ..... 33-34-35

Warsaw, Indiana, Adopts Stromberg Board—by C. F. Sanders ..... 35

Vacuum Tube Theory and Practice ..... 38-40-54

The Technical Clearing House—by B. C. Burden ..... 42-44

Minnesota Telephone Men Convene ..... 44-54

Cape Girardeau Has New Exchange Building—by E. R. Sears ..... 46-48-50

With Manufacturers and Jobbers ..... 52


## Index to Advertisers


A

American Cross Arm & Conduit Co. ..... 41
American Electric Co., Inc. ..... 6
American Telephone & Telegraph Co. ..... 36-37
Automatic Electric Co. ..... 28-29
Automatic Tel. Mfg., Ltd. ..... —
Acorn Insulated Wire Co. ..... 55

B

Berry, L. M. ..... 54
Bernz Co., Otto ..... —
Blake Signal & Mfg. Co. ..... 49
Block, Lynton T., & Co. ..... 7
Bond Electric Corp. ..... 49
Bowdle Accounting System ..... —
Brown, W. P., & Sons Lbr. Co. ..... —
Buckeye Telephone & Supply Co. ..... 54

C

Calculagraph Co. ..... 39
Carolina Wood Preserving Co. ..... —
Cook Electric Co. ..... 14
T. J. Cope, Inc. ..... 49
Curtin-Howe Corp. ..... 1
B. J. Carney & Co. ..... 41

E

Electric Storage Battery Co. ..... 10

F

Forged Steel Products Co. ..... 13
Ft. Dearborn Hotel ..... —
French Battery Co. ..... 39

G

Graybar Electric Co. ..... 45

H

Harrison Hotel ..... 53
Herdrich & Boggs ..... 54
Holtzer-Cabot Electric Co. ..... —

I

Indiana Steel & Wire Co. ..... 47
Ind. Sales & Eng. Co. ..... 43

K

Kaul Clay Mfg. Co. ..... —
Kearney Corp., Jas. R ..... —
Kellogg Switchboard & Supply Co. ..... 4-5
Kester Solder Co. ..... 13

L

Lorraine Hotel ..... 53

M

MacGillis & Gibbs Co., The ..... 41
Master Plier Corp. ..... —
W. N. Matthews Corp. ..... —
Michigan Pole & Tie Co. ..... 10
Mineralac Electric Co. ..... 47
Minnesota Electric Co. ..... 54

N

National Cable Compound Co. ..... 53
National Carbon Co. ..... 11
National Fireproofing Co. ..... —
National Lumber & Creosoting Co. ..... 39
Naugle Pole & Tie ..... 41
Northern White Cedar Ass'n ..... 12

P

Partridge, T. M., Co. ..... 41
Phillips, Eugene F., Electrical Works, Ltd. ..... 43

R

Rebuilt Electric Equipment Co. ..... 54
Reliable Electric Co. ..... 2
Runzel-Lenz Elec. Mfg. Co. ..... 49

S

Sands Electric Co. ..... 1
Sherman Hotel ..... 53
Signal Eng. & Mfg. Co. ..... —
Stewart Bros. ..... 49
Stromberg-Carlson Tel. Mfg. Co. ..... 8-9-56
Suttle Equipment Co. ..... 45

T

Telephone Repair Shop ..... 54
Teletype Corporation ..... 3
Telkor, Inc. ..... 47
Templeton-Kenly Co. ..... 41
Texas Creosoting Co. ..... —

U

Universal Specialty Co. ..... 54
Unique Mfg. Co. ..... 50

W

Welker, J. H. ..... —
Western Electric ..... 51
J. G. Wray & Co. ..... 54
P. Wall Mfg. Supply Co. ..... 1
Waterbury Battery Co. ..... 1



*dependable*

**NORTHERN WHITE CEDAR POLES**

that offer *utmost* in Quality and Value.

*Guaranteed* Butt Treatments

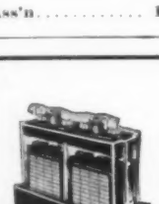
**MICHIGAN POLE & TIE CO.**

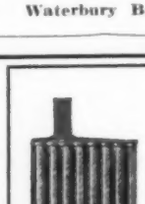
NORTHERN AND WESTERN POLES

NEWBERRY, MICHIGAN

Reed City, Mich. YARDS St. Paul, Minn.







DEPENDABILITY . . . long life . . . economical operating and maintenance costs are the reasons why the use of Exides is increasing in P.B.X. service.

**EXIDE-IRONCLAD P.B.X. BATTERIES**

Exide - Ironclad Battery, type B.I.-5, especially designed and constructed for P.B.X. service.

Tubular construction of Exide Ironclad positive plate gives longer battery life.

Exide BATTERIES

THE ELECTRIC STORAGE BATTERY CO., PHILADELPHIA

# Telephone Engineer

Volume 35 FEBRUARY, 1931 No. 2

## Hitting the Upgrade for Nineteen-Thirty-One

Here we are, face to face with something new and impelling. It is 1931. We cannot turn around and go back, but there are two roads from which to choose stretching ahead of us. One is smooth and well-shaded with frequent resting places. As it winds around and down the hill-side, its shady depths invite us to follow this route. Traveling along this road should be easy and pleasant. We are tempted.

Especially are we tempted when we look up the other road which leads over rocks and seems to have frequent detours. Yes, we are tempted to coast down the smooth road, refusing to face the fact that it will lead only to stagnation or failure. But though the going may be rough as we travel the up-hill road, there is a beautiful view from the summit to reward us for our efforts, and which will inspire us to larger possibilities and surer methods for success.

Occasionally we meet telephone company executives who say: "We can go no farther; we have reached a full saturation of telephone growth both in station extent and revenue volume." From the moment such a decision is reached, that executive has turned into the smooth, down-hill road, and you may be sure his company will go tumbling after him.

In the first place, "saturation point" is a mythical term which is often mis-used. As far as we know the saturation point has never been reached in business. However, the term is used to indicate business "stagnation" rather than "saturation."

Scientifically, the saturation point is that reached when a piece of cloth (for example) has absorbed every bit of moisture it can contain and can hold no more. But, when this moisture evaporates, more can be held in the piece of cloth.

Thus, the saturation point in business would be an ideal state of affairs. It would mean an assured, stabilized, certain amount of business. For "saturation" would be that point at which all equipment and service were provided in all quarters, and new business merely consisted of substituting new and modern equipment and service for the old, as fast as the old became obsolete or the new more desirable. And thus, the saturation point is a goal much to be desired.

However, as soon as telephone company heads believed their concern had achieved saturation, and sat back to let things take care of themselves, there would be no saturation. Business would tend to lag. It is vitally important that telephone men keep constantly improving and modernizing their plant and equipment in order to hold the business they already have, as well as to strive for new business.

There are in business two types of successful men. One travels fast when he's going with the tide, but he is a helpless drifter when the tide ebbs. He can roll down hill but he can't fight the up-hill battle. Many are those who have been coasting along this smooth down-hill road for the past few years, perhaps unwittingly. They have prospered and perhaps have believed firmly in themselves and their own sterling characters. But they have become soft. Now that they are faced with the decision of the easy road or the hard road, they are beset with doubts, and excuse themselves with plagiarisms such as "the saturation point" as they turn to continue blithely on their way—down.

The other type of successful man is the one whose success has been of slower growth. He has forged ahead, laying foundation on foundation, and never giving up when one layer developed a few cracks. Now when rough spots and detours loom ahead, he is not alarmed, but climbs onward and upward, realizing that another smooth stretch lies ahead if he can but surmount the intervening difficult places.

If the telephone business is to prosper it must be encouraged by efficiency and enterprise. Scrutinize your poles and wires, your telephones and switchboards. If they have been in use for twenty or thirty years, replace them with new and modern equipment. Such a move will arouse interest and enthusiasm among your patrons. It is an old business maxim that you have to spend money to make money. Keep insistently moving forward, in order not to slip backward. The telephone industry has become an established necessity, and the success or failure of any given company depends upon its man-

agement, and nothing else. Let's become modern-minded. This year, 1931, is a new and modern year in which all sorts of things are going to appear. Hit that trail up the hill of 1931.

---

**Rates, and the Public Commissions,** In almost every state of the Union, legislators who soon will gather in their respective capital cities, will have at least one problem in common, namely, the adjustment of rates charged by public utilities. Particular emphasis will be placed on telephone rates and valuations.

We are faced by this question: Is there a just cause for this continual agitation against an enterprise which has done much for general progress and prosperity? This may be answered in two ways.

To the extent that telephone managements have unnecessarily antagonized the public estimate of fairness and honesty, the answer must be in the affirmative. In instances where telephone companies have managed their finances and public relations with consistent integrity, the reply should be in the negative.

Unfortunately, speculators, here and there, with little or no knowledge of telephone affairs and their relation to the public, have "muscled" into the industry with greatly exaggerated notions of its "get-rich-quick" possibilities. They have manipulated property valuations in order to justify exorbitant rate schedules. Commissions and courts, to which appeal is made by subscribers for justification of increased rates, can only decide the cases before them on the law and the evidence. Telephone patrons are rarely organized and prepared to fight in court and consequently are at the mercy of indefectible evidence produced by the telephone company. Subscribers therefore appeal to the lawmakers to protect them from what they consider impositions on the part of legally established monopolies.

One hears complaints of overcharges and oppressive rule in connection with utility management; one reads sensational newspaper stories which question utility practices. The public is ever willing to feel abused. As a consequence, it is not strange that to fight utility practices has come to be considered good campaign thunder. Following election, these legislators who uttered damning accusations against utilities during their campaign, repeat their charges on the floors of legislatures and congress. Though they may not succeed in effecting destructive legislation, they often do succeed in fanning public opinion into a flame of resentment against all utilities. The telephone industry has been made to suffer from such tactics resulting in opposition to telephone companies and a complete lack of cooperation on the part of subscribers, in some districts where feeling runs high.

Most of this agitation is caused by the activities of a very few interlopers in the telephone business who are there for the purpose of realizing quick profits in the sale of securities or the resale of properties, without regard to the welfare of the utilities or the reputation of the industry. They have floated sufficient securities to pay for their venture, they have fixed high salaries for themselves, and they have piled personal expense into scandalous sums which the paying public naturally considers outrageous. Thus they have become the drop of impurity which contaminates the entire industry. Legislative threats and other dangerous possibilities are the result.

If the many who are honest are not to pay for the few who are dishonest, telephone leaders throughout the county should exert themselves to scrutinize their own industry for the root of the trouble, and assert their opposition to the use of damaging tactics. If the industry could solve its own difficulties there would be less danger from legislation on the part of politicians who seek the good will of the public but are entirely unversed in a knowledge of the functioning of public utilities.

---

**Service Connection and Moving Fees** The problem bothering a number of state telephone associations is whether charges should be made for installing and removing telephones; and if such service charges are made, how large they can be without discouraging subscribers.

In most states the so-called Burleson installation and moving charges, established just after the close of the war by the U. S. Post Office department, then in control of wire and wireless communication, have been continued. In some instances these charges have been altered somewhat, but with the exception of one or two, the necessity of service connection and moving charges has been recognized in all states, and some charge adopted.

This custom is believed to show impartiality to both company and patrons, and is the result of a careful survey and analysis made by representatives of the public, of courts and commissions, and of telephone managements, covering actual costs of installation and removing telephones.

Cost and equation experts have agreed unanimously that it costs money to install, move, or take out telephones and the connection apparatus. They agree that these costs are not absorbed by the service expense for which rental is charged. And they also are all of the opinion that the patron who orders this work done should bear the expense, rather than distributing the cost among those who do not require the service by increasing the cost of rentals to all patrons.

However, the crux of the matter is not so much whether such work is an expense and who should pay for it, as how much cost will such contingencies bear without a prohibitive inflow of business? Some commissions contend that the $3.50 installation charge (according to the Burleson rates) is a bar to patronage to the extent of a possible revenue far in excess of the total amount which would be collected as service charges.

Manifestly the question is one for serious consideration. Our business needs all the growth and revenue we can invite. And, in this matter of service connections and moving charges, if there is a genius who can figure out a schedule which will protect the stable patron against the expensiveness of the roving class, leaving our doors invitingly open for new patrons, yet so adjusted as to hold our old ones, he will indeed be a benefactor for the telephone business.

# Relays Involved in Incoming Trunk Circuit

**Sequences of Operations Performed in Handling Incoming Calls Are Here Described by J. H. Levis, Jr., Telephone Engineer, Rochester, N. Y., in the Eighth of His Series of Articles on Straightforward Trunking Written Exclusively for This Publication.**

In the last seven issues of TELEPHONE ENGINEER the straightforward trunking system has been described in detail from the "B" switchboard keyshelf and plug board equipment to each relay function and purpose, starting from the substation local "A" cord circuit, "A" operator's circuit, and outgoing lamp indicating trunk circuit to "B" incoming trunk circuit.

The installments to follow will show the relays that are involved in the incoming trunk circuit as the various sequences of operations are performed by the "B" operator in handling an incoming call.

The circuit diagram of the operations will show the relays in operated positions and only the contacts involved in the operations described and which pass through non-operated relays will be shown. All other contacts will be omitted. The circuit scheme used is the same as shown in the October, 1930, issue of TELEPHONE ENGINEER. This will be done so that the portion of the circuit being described will coincide exactly with the entire circuit diagram and so that no confusion will be encountered in the study of partial circuit functions and their relation to the complete circuit layout. Resistance value of relays will not be given in the following installments as they already have been given in the previous installments describing the trunk circuit.

The trunk circuit is designed to operate on a direct current potential of 40 volts and all relay adjustments are made on the basis of a possible variation in operating voltage of a minimum of 36 volts and a maximum of 45 volts. With this variation, accurate and reliable relay operation is attained and at the same time the adjustments warrant very reliable contact pressures, insuring continuous make and break contacts during circuit operations. This is an important requirement in circuits of this type where there is such a great number of common relays upon which all of the position trunk circuits depend.

In checking the actual relay operations from relay to relay through contacts it will be noted that the relay contacts and some of the windings show a ground symbol, similar to an inverted triangle and shown in solid black. This is positive battery. The negative side of the battery, more generally known as the live side of the battery, is shown as a small solid black bar. The above symbols will be noticed readily in tracing the circuit operations.

In the circuit diagram, on the incoming end, a coil is shown connected to the tip and ring of the trunk circuit. This coil has one of its windings connected to ground and the other to battery. This represents the battery supply relay in

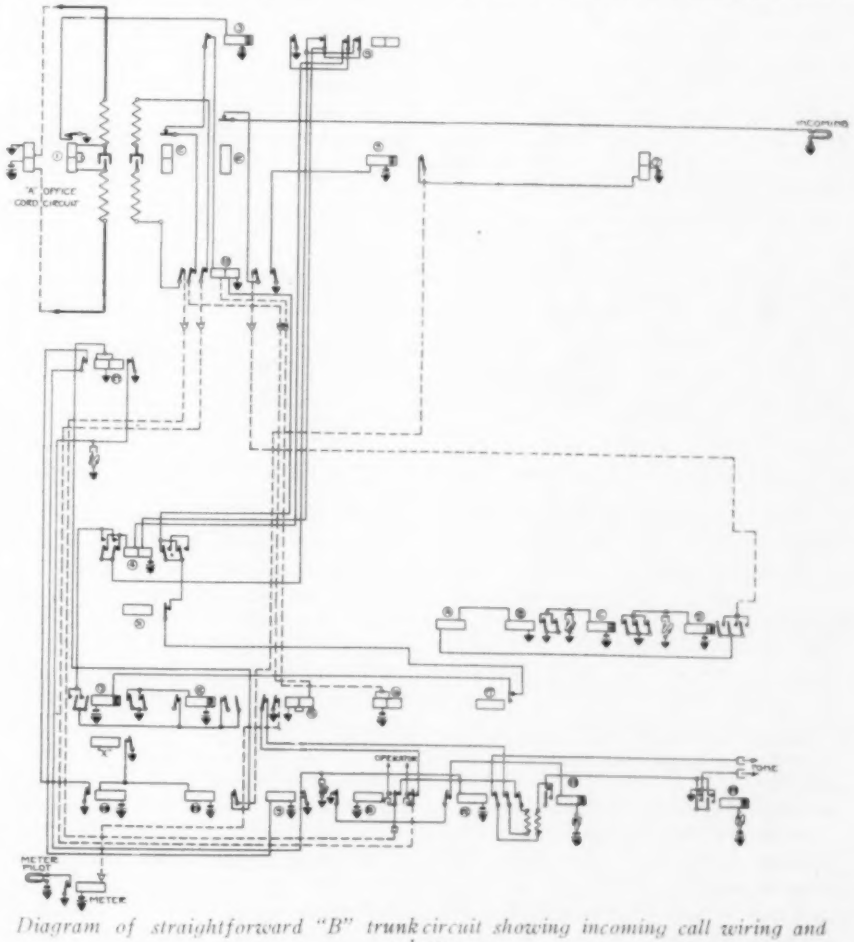



*Diagram of straightforward "B" trunk circuit showing incoming call wiring and relays.*

(*Continued on page* 31)

# Our Engineering and Management Course

**This Is the First Chapter in a Course of Practical Technical Instruction Prepared for Exclusive Publication in Telephone Engineer by B. C. Burden, Transmission Engineer, Lincoln Telephone and Telegraph Company.**

### Preface

The purpose and intent of TELEPHONE ENGINEER'S Engineering and Management Course is to offer to the exchange manager or wire chief a monthly study article dealing with the theory and operation of small and medium sized telephone exchanges.

This course will embrace both the theoretical and practical aspects of telephone plant operation. While primarily for plant men, some discussion will be included on traffic and commercial features of management. Some more or less elementary theory will need to be treated in order that the course will be useful to those new in the telephone field; however, each article will contain much useful data and facts for the "old timers."

Each month's article will be accompanied by a number of questions relative to the subject matter covered. It is suggested that each article be filed as it is planned to continue this course for an indefinite period. At the end of 1931 an index will be given covering the sections published during 1931.

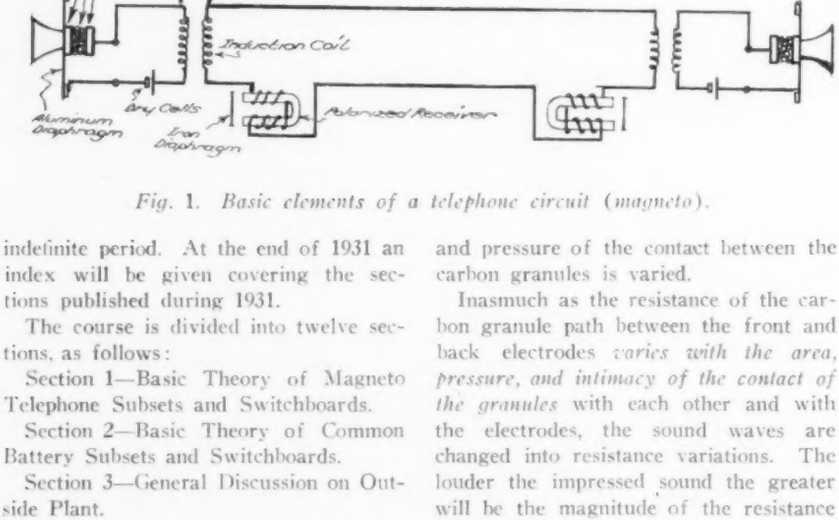



*Fig. 1. Basic elements of a telephone circuit (magneto).*

The course is divided into twelve sections, as follows:

Section 1—Basic Theory of Magneto Telephone Subsets and Switchboards.

Section 2—Basic Theory of Common Battery Subsets and Switchboards.

Section 3—General Discussion on Outside Plant.

Section 4—Inside Plant Design.

Section 5—Outside Plant Design.

Section 6—Central Office Equipment Installation.

Section 7—Outside Plant Construction.

Section 8—Maintenance of Telephone Plant.

Section 9—Toll Practices.

Section 10—Plant Records.

Section 11—Office Management.

Section 12—Commercial Practices.

Section 1—*Basic Theory and Practice of Magneto Telephone Subsets and Switchboards.*

### Theory of Transmitters and Receivers

A telephone transmitter should be considered as a device which converts sound waves into resistance variations, and the resistance variations in turn set up an electrical wave variation which is of the same shape as the impressed sound wave.

Figure 1 illustrates the basic elements of a transmitter connected in a local battery telephone circuit. It will be noted that it consists essentially of a mouthpiece for collecting and concentrating the sound waves, a diaphragm on which the sound waves impinge, a front carbon electrode rigidly attached to the diaphragm, a back carbon electrode supported by a metal "bridge," and a quantity of granular carbon placed between front and back electrodes.

The operation is as follows: When sound waves are impressed against the diaphragm it vibrates and the intimacy and pressure of the contact between the carbon granules is varied.

Inasmuch as the resistance of the carbon granule path between the front and back electrodes *varies with the area, pressure, and intimacy of the contact of the granules* with each other and with the electrodes, the sound waves are changed into resistance variations. The louder the impressed sound the greater will be the magnitude of the resistance variation.

Again referring to Figure 1, it will be noted that a direct current flows through the series circuit consisting of battery, transmitter and primary of the induction coil. With no sound impressed on the transmitter, the current in this series circuit will be constant, but when the transmitter is spoken into the resistance variation due to the moving carbon granules will cause the current to increase and decrease above the normal value. This is shown in Figure 2. It will be noted that the sound waves have been converted into electrical waves which vary in a manner nearly identical with that of the original sound waves.

Let us now consider how the varying current in the primary circuit of a magneto telephone subset is converted into alternating current before passing out over the line wires to the distant telephone.

Referring to Figure 2, it will be seen that the increasing and decreasing direct current flowing in the primary of the induction coil will, due to the increasing and decreasing magnetic flux set up, induce an alternating voltage across the secondary winding. The induction coil is merely a typical electrical transformer especially adapted for telephone purposes. It will be noted that the induction coil serves to confine the direct current to the primary circuit.

The varying alternating voltage set up across the secondary winding sets up an alternating current flow in the line to the distant telephone.

### Theory of Telephone Receiver

The varying alternating current coming from the transmitting subset reaches the listening subset and passes through the series circuit consisting of receiver and secondary of the induction coil in series. By reference to Figure 3 it will be observed that the receiver consists essentially of a permanent U shaped magnet, a set of coils wound at the extremities of the two poles of the magnet, and an iron diaphragm so supported as to be free to vibrate.

When the incoming alternating current passes through the receiver coils, the resulting magnetic flux set up will either oppose or assist the normal flux of the permanent magnet, depending on the direction of current flow through the coils.

When the electro-magnetic flux assists that due to the permanent magnet, the diaphragm is attracted closer to the pole pieces, and when the two fluxes are in opposition, the diaphragm recedes from its normally "dished condition." This effect is brought out in Figure 4.

Referring to Figure 4-A, it is evident that the permanent magnet is an essential element in the receiver operation, for without it the original sound wave will be distorted due to the input frequency being doubled. For example, if no permanent magnet was used and we im-

pressed a 1,000 c. across the receiver terminals, we would get a 2,000 c. sound wave from the receiver.

### The Telephone Circuit

Now that we have discussed the general theory of the two basic elements of any telephone circuit, let us consider the subset circuit of a magneto telephone.

Figure 5 illustrates the circuit arrangement of present day magneto-local battery telephones.

It will be noted that in addition to the basic elements, that provision is provided for connecting the receiver to the line and for closing the local battery circuit

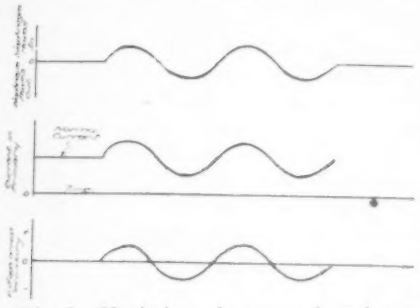


*Fig. 2. Variation of current in primary and secondary circuit due to change in transmitter resistance.*

by means of a "hook switch" which is operated by the removal of the receiver. A small alternating current generator is provided for signalling the operator or other parties on the same line, and an electro-magnetic tapper serves to signal the subscriber.

The generator is provided with a set of contacts which connect the generator across the line when the generator crank is turned. It is necessary that the generator be disconnected from the line at all times except when signalling, as the low resistance armature winding would act as a shunt path for ringing and talking currents.

### Design Features of Transmitters, Receivers, Induction Coils, etc.

*Transmitters*

There are two types of transmitters in use. The most common type has the carbon cup rigidly attached to the "solid back" with the front electrode attached to the diaphragm. The Western Electric, Stromberg-Carlson, and Automatic Electric transmitters are of this type. The second class of transmitters is referred to as the "reverse type" and is manufactured by the Kellogg Company. It will be noted that this transmitter has the carbon cup recessed in the aluminum diaphragm and the back electrode attached to the mica window in the carbon cup. Figure 6 illustrates schematically the two types. Some form of damping spring is always provided on transmitters for improving the quality of the speech, and to make the transmitter less sensitive to room noises.

The average resistance of local battery transmitter ranges from 20 to 50 ohms. Some of the equipment manufacturers utilize low resistance transmitters for local battery telephones and higher resistance transmitters for common battery telephones, while others utilize a high resistance transmitter for both local and common battery telephones.

The service for which transmitters are designed is sometimes indicated by means of a small L or C stamped on the front plate, the L indicating local battery and the C common battery.

The use of a common battery high resistance transmitter on a local telephone will, unless the telephone is designed for use with such transmitters, result in a considerable reduction in transmitting efficiency. The use of a low resistance local battery transmitter on a common battery telephone may result in the transmitter becoming noisy due to a "burning effect" of the carbon granules.

Most local battery telephones are designed for use with two No. 6 dry cells; however, some of the manufacturers' sets can be used with three cells if desired. The additional cell boosts the transmission efficiency of the set. Inasmuch as the transmission efficiency falls off rapidly as the voltage of the transmitter dry cells decrease, it is necessary to have a definite program for the testing and replacing of batteries if poor transmission is to be avoided.

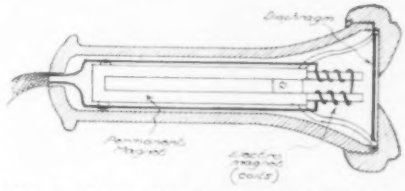


*Fig. 3. Essential elements of a polarized receiver.*

### Receivers

Receivers are generally wound to have a resistance of from 70 to 80 ohms and offer an impedance of from 200 to 300 ohms at average voice frequencies (1,000 cycles).

The spacing of the air gap between pole pieces and diaphragm is very important and is usually adjusted at the factory to be .010" to .013", depending on the make. If the gap is too small there is danger of the iron diaphragm freezing to the pole pieces due to the attraction of the permanent magnet, and if too large the receiving efficiency is greatly reduced and distortion introduced.

No provision is made in present day receivers for the adjustment of this gap in the field, as it is assumed that the correct gap is fixed at the factory and there should be no need for such an adjustment.

Receiver diaphragms are composed of a ferrotype iron with the side exposed to the ear lacquered to prevent the moisture which normally condenses from causing the diaphragm to rust.

Permanent magnets are made from tungsten magnet steel and are strongly magnetized. Their magnetic strength is such that they should be able to support a 27-ounce soft iron weight.

It is customary to refer to receivers of the permanent magnet type as "polarized receivers," due to the magnetic polarity of the pole pieces being fixed by the permanent magnet.

### Induction Coils

*Induction coils,* in addition to confining the direct current to the primary or local circuit, also serve to match the impedance of the transmitter with that of the line and receiver. While any induction coil will usually work, it is necessary to use the coil designed for a given type of transmitter for maximum efficiency.

The cores of present day induction coils are constructed of flat strips of silicon iron or of fine iron wire. The turn radio between primary and secondary is 1 to 4. One popular make of coil which is typical of local battery induction coils has 380 turns No. 26 on the primary and 1,520 turns on the secondary. The primary resistance is 1.8 ohms and the secondary 14 ohms.

### Generators

Generators are generally referred to as "two," "three," or "five bar" types, depending on the number of permanent magnets used. For one and two party lines the two or three bar generators are suitable, and for multi-party rural lines a five bar should be used.

The power output of the generators is proportional to the strength of the permanent magnet field and the resistance of the armature winding. Because of the shunting effect of a number of bridged bells it is necessary to have sufficient power to ring all bells on the line, as well as the office drop. The voltage output of a generator varies with the

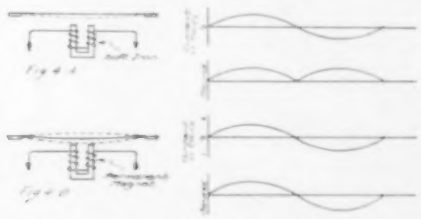


*Fig. 4. Effect of permanent magnet in polarized receiver.*

speed at which the generator armature is turned and will when turned in a normal manner develop from 50 to 70 volts, depending on the magnet strength. The frequency varies with speed and will be about 17 to 22 cycles at normal speeds.

Generator shunt springs are arranged so that when the generator is not operated, one side of the armature will be disconnected from the line and a short

will be placed across the armature. The armature is shorted to prevent lightning damage to the winding.

The five bar generators are usually wound with larger wire and fewer turns than the two or three bar generators,

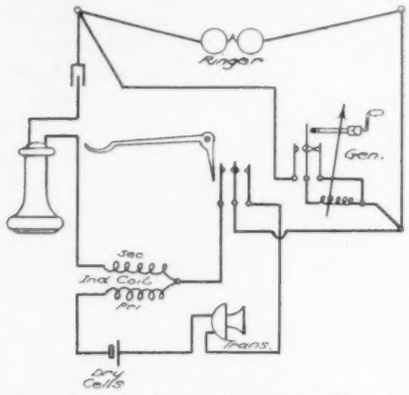



*Fig. 5. Circuit diagram—typical magneto telephone.*

hence, have a greater current output with less drop in voltage. The resistance of 5 bar generators is around 160 ohms, and the winding usually consists of several thousand turns of No. 30 single silk covered copper wire.

**Ringers.**

There are two fundamental types of ringers in use, which are known as the "polarized" and the "harmonic type." The schematic of the polarized ringer is shown in Figure 7. This type ringer, it will be noted, consists of two soft iron cores on which coils are wound, a permanent magnet fastened to the core at one end, and spaced close to the tapper armature at the other end. This results

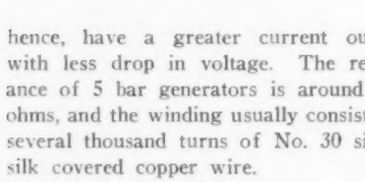



*Fig. 6. Two types of transmitters.*

in the two cores having south poles set up at the armature end, as a result of magnetic induction from the permanent magnet.

The coils are wound on the cores so that when current is passed through them that the resulting flux at the extremities of the two cores is always of opposite polarity. With an alternating current flowing through the coils, the magnetic polarity of the two cores will alternate, being first north, then south. This will result in one side of the armature being attracted and the other repelled, and as the current reverses in the coils, the side of the armature which is attracted will be repelled, and vice versa. It is evident that for satisfactory action of the ringer the permanent magnet must be sufficiently strong to properly polarize the armature.

Polarized ringers may be equipped with biasing springs for use on common battery lines, and cases where pulsating d. c. ringing current is used. A small spring is so adjusted as to exert a pull on the side of the armature which would normally be repelled by the pulsating current flow.

Bells of the polarized type are generally wound for 1,000 ohms for one and two party service, and 1,600 ohms for multi-party rural lines.

The Harmonic type ringer operates in a manner identical with that of the polarized ringer except that the armature is attached to a stiff spring rather than being pivoted, as is the case with the polarized ringer.

A spring or reed rigidly fastened at one end has a characteristic or natural vibration, the rate of this vibration being a function of the stiffness of the spring and the length and weight of the attached reed.

Such a tuned reed can of course be

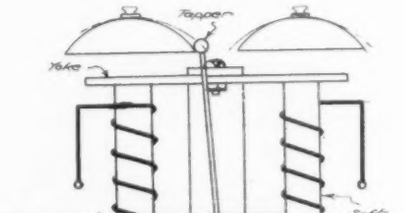



*Fig. 7. Polarized telephone ringer.*

vibrated at any desired period, provided sufficient force is applied. However, by applying only a small force of the same period as the natural frequency of the reed, vigorous vibration can be obtained, while at any other frequency the reed will not respond.

Harmonic ringing was designed as a means of selective signaling on party lines. The frequencies ordinarily used on present day harmonic systems are 16, 20, 25, 30, 33, 42, 50, 54, 66 cycles.

By the use of five frequencies and with five ringers connected from each side of the line to ground, full selective ringing can be obtained on a ten-party line.

It is now recognized in the design of a harmonic ringing system that the various frequencies used should not be multiples of each other, as this tends to cause cross ringing. While a number of four-party systems are in use over the country which utilize 16⅔, 33⅓, 50 and 66⅔ cycle ringers, such systems are now generally designed for 30, 42, 54 and 66 cycles, which are not multiples.

Harmonic ringing systems require higher voltages for successful operation than due straight polarized ringers. The voltages range from 80 to 150 volts, being higher for the higher frequency ringers.

The resistance of harmonic ringers is generally higher for the lower frequencies. For example, in one well known type of harmonic system the 16⅔ cycle ringer is 2,500 ohms, while the 33⅓, the 50, and the 66⅔ cycle ringers are all 500 ohms. The low frequency ringer is wound to a higher impedance to reduce the tendency to cross ring which exists between the higher and lower frequencies.

## QUESTION SECTION

No. 1—How does a transmitter convert sound waves into electrical variations?

No. 2—What is the difference in the character of the current in the primary and secondary circuits of a telephone (local battery) when the transmitter is operated?

No. 3—What is the purpose of the permanent magnet in a receiver?

No. 4—Would a receiver operate with the permanent magnet removed?

No. 5—What is the difference between the "regular" and the "reversed" types of transmitters?

No. 6—What is the correct air gap spacing between pole pieces and diaphragm in a receiver?

No. 7—Why is an induction coil necessary?

No. 8—Should the armature winding of a generator be shorted when the generator is idle?

No. 9—Will a polarized ringer operate if the permanent magnet is removed?

No. 10—If the contacts which connect the generator winding to the line fail to open when the generator handle is released, will this interfere with the signaling by other telephones on the same line?

## CONVENTION SCHEDULE

**Oklahoma Utilities Association, Oklahoma City, Okla., March 10, 11, Huckins Hotel.**

**Texas Independent Telephone Association, Forth Worth, Texas Hotel, March 24, 25, 26, 1931.**

**Iowa Independent Telephone Association, Hotel Fort Des Moines, Des Moines, April 7, 8 and 9.**

**Indiana Telephone Association, Indianapolis, May 6 and 7, Claypool Hotel.**

**Up-State Telephone Association, Rochester, N. Y., May 20, 21, Seneca Hotel.**

**Pennsylvania State Telephone & Traffic Association, Hotel Penn Harris, Harrisburg, May 26, 27 and 28.**

**Kansas Telephone Association, Abilene, June 2, 3, 4, The Sunflower Hotel.**

# Convenient Methods of Stringing Drop Wire

**Ray Blain Advises Number 17 Twisted Pair Wire for Use as Drop Wire; Explains Most Satisfactory Ways of Stringing Drop to Pole and House Attachments and Says Wire Span Should Be Kept Short; Urges That Wire Clear Trees and Tells How to Protect Wire When Proximity to Trees Is Unavoidable.**

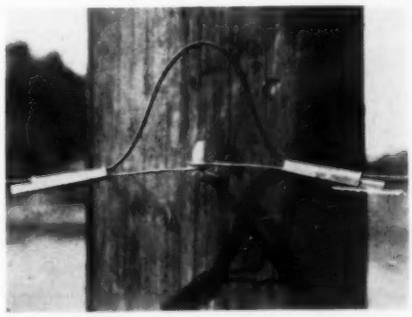
Drop wiring is that part of the telephone plant which connects the protector at the subscriber's station to the permanent plant cable or in some cases an open wire lead which in turn connects to the cable terminal. Why they selected the name of drop wire for this part of the plant has always been a mystery to me and the only reason I can assign is that it drops off from the main lead somewhat like the branches of a tree. Be that as it may, this is one of the most important parts of the plant and if not properly constructed will be a continual source of trouble and expense. Great improvement has been made during the past few years in the quality of all drop wire and I don't doubt in the slightest but that some drops now in service will have a life of 10 to 15 years and possibly longer.

### Selection of Drop Wire

In the old days drops were usually strung with No. 14 iron wire and as they were never pulled very tight, caused considerable trouble wrapping together. Later, one wire was strung bare and the other was insulated iron wire, and when these twisted together they would not cause trouble unless left in that condition for a period of time. The first twisted pair wire which came out was No. 14 copper with a large, heavy insulation. While this was some improvement over anything we had previously used it was not entirely satisfactory as it was so heavy the weight in many cases caused the tie wire to cut through the insulation and cause trouble. Also the wire was so large it was difficult to connect into the cable terminal.

The next development was the Copperweld No. 17 twisted pair which is a steel wire having a copper covering welded to it. Copperweld has a strength much greater than copper and the conductivity is practically the same. This wire is much lighter and also has a much better insulation than the old type No. 14. Phosphor bronze is also used for drop wire with complete success. While the No. 14 was usually tied in on a single groove knob its excess weight, if permitted to cross on the knob, usually cut the insulation and a short circuit resulted. About the time the No. 17 became popular the double and four groove knobs came out and with one wire in each groove going around the knob it was made much more serviceable. We thought this was the height of perfection until a few years ago when the No. 17 parallel made its appearance. This is somewhat like No. 17 twisted pair except that the two conductors are first insulated separately and then pressed close together and in parallel under one outer braid covering.

The serviceability of the No. 17 twisted pair wire is remarkable. A few years ago in Manila the "Huron" flagship of the Asiatic Fleet dropped anchor inside the breakwater and requested that they be furnished telephone service. As no sub-



*Two clamps used to turn corner.*

marine cable of a suitable type was available we conceived the idea of attaching weights to a length of No. 17 drop wire and using it as a cable. They all claimed it would not work an hour but we hired a gasoline launch with a couple of sailors, and after losing one coil of wire in the bay chiefly because the sailors were too speedy with the launch, we finally got a line of several hundred feet out to the ship. A weight was attached to the wire about fifty feet apart with a tie similar to the tie on a knob. A common battery telephone worked over this submarine line for about ten days without causing one minute's trouble. Before removing the wire it was tested and found to have practically the same insulation as when submerged. A wire tested in this manner under salt water speaks well for its serviceability.

Regardless of which type of wire is selected to use for drops in any exchange, it is all strung in about the same manner as certain rules must be observed if it is to give maximum life and service.

### Stringing the Drop

The pole attachments are generally the first consideration when starting to string a new drop. With twisted pair wire this attachment is generally an "L" type pole bracket attached to the pole with fetter drive screws and will hold two 4-groove knobs and handle the deadening of four drop wires. I always prefer that this fixture be installed at least 10 inches above the messenger so that drops which run a span or so before leaving the cable lead are up in the clear. Thus the cable can be ridden in a car without constantly fighting drops out of the way. If a guard arm is used as is standard practice with some companies, then the fixtures should be installed on it. I like the plan of running a row of bridle rings down each side of the pole from the knob fixtures and have drops enter the cable terminal on the same side from which it will connect to the punchings.

The house attachment is generally located at the most convenient point so as to provide a clear run to the pole and make as short as possible run to the house entrance. Drops should always be routed if possible, so as to avoid trees, that enemy which is so destructive to drop wire and probably causes more grief than all other drop wire troubles combined. If it is impossible to clear trees, a tree wire with a special tough braid which has considerable resistance to tree abrasion should be used. In some cases it is advisable to protect wire when a tree cannot be avoided by placing a suitable wooden guard on it and taping in place. Flexible loom of the type used in house lighting slipped on over the wire and taped in place also makes a very serviceable tree guard. Sometimes it is impossible to get a clearance from house to pole and avoid trees and in such cases a line can usually be obtained between the house and some point on the messenger that will make a clear path for the wire.

Suitable clamps can be procured which attach to the messenger holding a knob in correct position to run drops of this nature. Attachments should never be placed on trees if it can possibly be avoided as the swaying of a tree in the wind will greatly shorten the life of a drop. The house attachment may be a lightweight "L" bracket which holds a two-groove knob to it with a stove bolt. There is also a screw type fixture which holds a double groove knob that can be screwed into a wooden building at any angle making a very convenient arrangement. The termination and use of par-

allel drop wire will be taken up in a separate paragraph.

Drop wire spans should be kept as short as possible and it is generally not considered good practice to have a span longer than 150 feet, although sometimes spans as long as 200 feet are used with fair success. The slack will generally increase in a long span after being in service for a time and make it necessary to repull the wire. Necessary slack should always be left in a drop wire if it is to give maximum service. The following table gives what I believe to be an average amount necessary to meet conditions in the average exchange.

| Span length in feet | Sag allowed in inches |
|---|---|
| 75 | 6 |
| 100 | 12 |
| 125 | 18 |
| 150 | 26 |

When this amount of sag cannot be obtained it is a good plan to shorten the length of the span or use higher poles. In a country where the wire is weighed down heavily with sleet in winter it is generally a good plan to leave even more slack than that mentioned in the above table at the time of stringing.

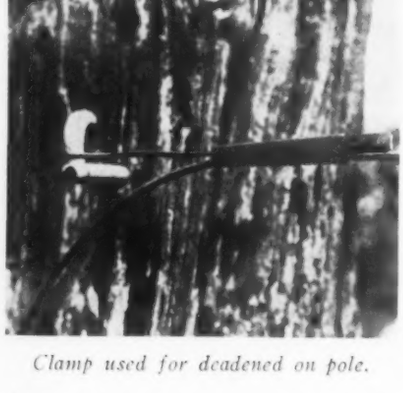
### Drop Run on Building

The run on the building from the point of attachment to the entrance at the protector should be as short and direct as possible. That is, direct by making vertical and horizontal runs. Wire should never be run at an angle across the side of a building. The wire will usually be attached to a building with either knobs or small bridle rings. Lately there is coming into general use a small cleat to hold wire to buildings which is very neat, quick to install and from all indications will be quite serviceable. I have always favored the bridle ring for intermediate supports and a knob for the attachment to the building and again at the point where it enters the wall to the protector. Attachments on a horizontal run should be spaced from 4 to 8 feet apart and from 5 to 10 feet on a vertical run. Attachments spaced closer than this while not absolutely necessary make a much neater job than when spaced farther apart. All intermediate supports should be equally spaced for appearance sake. The wire run on a building where it crosses over a pipe or conduit, over a drain pipe or around a corner should always be protected with tape, a porcelain tube or by flexible loom. Wire should never cross over a window and should be located so that it cannot be damaged from snow and ice sliding off the roof.

Wire generally enters the house through a porcelain tube. The hole for this tube should be drilled slanting upward so that moisture will not enter through it. Locate the last attachment as close as possible, that is, within a few inches of the tube entrance. Wrap a few layers of tape around the wire and pull snug into the tube to insure it being water tight. The old drip loop of which we were formerly so proud has been cast into the discard and the run from the last knob to the tube should be straight and direct. Of course the last knob can be located directly above, below or to one side of the tube wherever it is most convenient and the wire run straight from this point to the entrance tube. A dead-end on the last knob is not necessary and a straight tie makes a much neater job.

### Parallel Drop Wire

I have been trying to find out for a long time why parallel drop wire has not become popular and more generally used in the Independent field. Some of the larger companies have been using it for years with apparent success. One representative of a wire company when approached on the subject as to why they



*Clamp used for deadened on pole.*

didn't push this product stated that they could not guarantee its performance. I said, "Well, I know of drops which have given service five years without trouble." He replied, "So have I, but I don't know what kind of service a drop will give after being in service ten or fifteen years as parallel has not been in use that long."

There has recently been developed a clamp which can be used instead of a tie and knob for supporting parallel drop wire which I believe is due to make this type construction very popular within the next few years. We all know that the weakest point of our twisted pair drop wire is where the tie grips the knob and it is here that trouble generally develops first. It is a very difficult task to tie a twisted pair wire to a knob so that equal strain is placed on each wire of a pair and something that not all linemen can master. If the strain is unequal the insulation is probably cut on one wire and when sleet loads it heavy there is a probability of one wire of the pair breaking. The new clamp and parallel wire to my mind removes these difficulties as the clamp grips the wire evenly for a distance of about three inches. This clamp consists of a wedge shaped affair with a wire loop at one end. This wedge slips into a sleeve arrangement has a slight corrugation on the bottom for its full length. The wire is placed in this sleeve and the wedge slipped in and the loop placed over the support. When the strain comes on the wire the wedge tightens and the wire is gripped evenly for the full length of the clamp.

There has also been developed a drive hook which can be used instead of a knob, the loop of the clamp being simply slipped over it. The hook is shaped in such a manner as to prevent the loop ever jumping off of it. This clamp is used for dead ends and two of them can be used on one hook where the wire takes any angle turn. There has also been developed a clamp which is simply pinched shut over the wire with a pair of pliers and used as an intermediate support as it holds the strain in two directions. This clamp also hangs on the drive hook. If a knob run is already in service a special hook arrangement can be fastened to the ordinary knob and the intermediate clamp hung on it to prevent having two sets of fixtures on one pole line. The dead-end clamp can likewise be hung on a knob if desired.

I being unable to get much information on the parallel drop wire or these clamps arranged for the purchase of 10,000 feet of the wire and 100 of the dead-end type clamps. We strung drops with this material in an exchange located where the climate is not ideal and where the telephone plant is subjected to a little more than average weather hazards. We strung some drops in the usual manner, strung others of extra length, and pulled others as tight as possible. We imposed about every condition possible to shorten the life of a drop including that of running through trees and fastening a tight drop to a swaying tree. These drops have now been in service for two and one-half years and have not in that entire period developed a single case of trouble. I feel sure that this test installation would be equal to at least ten years' normal service under normal service conditions. To my mind the parallel drop wire and the clamps are far ahead of anything previously developed for drop work. One man can run more drops in a day with parallel wire, clamps and drive hooks and do a better job than three men can with the old style wire and older methods of construction. The wire is light which makes it easy to install and reduces the strain on the supports which should spell longer life. It is also smaller, offers less wind resistance and will not load as heavy as twisted pair with sleet. Some claim that long lines of parallel

will be noisy and crosstalk as it does not have the transpositions in it as twisted pair. This is not the case as there will be enough transpositions in it by just stringing it as one would ordinary twisted pair. If you don't believe this just try to string a drop of it and keep it absolutely straight and you will soon find that it is almost impossible. Removal of the clamps if a drop is to be recovered is easy by working the wedge out of the sleeve with a pair of side cutting or diagonal pliers. Both parts can be reused.

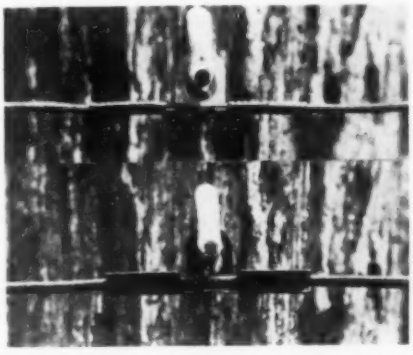
### Splicing Drop Wire

Splicing drop wire is something that few linemen enjoy or do properly so that it will not cause trouble later. The first operation when starting a splice in twisted pair wire is to cut off one conductor about six or seven inches shorter than the other. Then remove the insulation for a distance of three or four inches on each conductor and clean thoroughly. Just scraping with a pair of pliers is generally not sufficient and a small piece of emery cloth is much easier and quicker and does a better job. The ends of the other wire to be spliced should be prepared in the same manner. One method of splicing is to use the No. 17 two inch double tube copper sleeves. These sleeves are slipped on the cleaned wire back within about one-half inch of the insulation and the ends bent out slightly. The ends of the other wire are slipped into the other holes of the sleeves for the same distance and bent back and the ends all cut off. The sleeves are now given about 2½ to 3 complete twists. Either baby connectors or pliers can be used for sleeve twisters. Twists should be made one-half turn from each end alternating as this keeps the twist out of the wire. If desired the ends outside of the sleeves can be given several wraps around the insulation before cutting off and perhaps this makes enough better job to justify the additional time required and there is no danger of a pointed end piercing the insulation and causing a case of trouble later. The next operation is taping the splice which is not difficult if undertaken in the proper manner. The bared joint should be covered with two reverse layers of ¾ inch friction tape. The wrap should start in the center run out over the insulation on one end reverse and run out over the other end reverse again and end in the center. This makes a much neater job and it holds better than by starting and ending at the same end.

Parallel wire is spliced in about the same manner as twisted pair. Some object to this wire because they claim the removal of the outer braid is a different operation. I have found this can be done easily with an ordinary pocket knife if care is taken to have the wire straight and cut the outer braid evenly between the two conductors. Special tools are available which makes braid removal comparatively easy.

The joint in the parallel wire is taped in the same manner as the twisted pair wire except after completion both conductors are taped together for the full distance the outer braid has been removed with two reverse layers of tape.

If sleeves are not used a good two-wire splice can be made in the stripped



*Intermediate clamp open and closed.*

and cleaned wires letting the wrap extend for a few turns out over the insulation. These joints should be soldered well with a good grade of resin core solder. The open flame of a blow torch should never be used but a soldering copper should be heated on the torch and then the solder applied with it. If the open flame is used it will perhaps smoke up the connection so that a good soldering job will be impossible and the insulation will be damaged by the flames for considerable distance each side of the joint. Personally I prefer the soldered connection of drop wire but many use the sleeve method because they think it faster. If a man will light his torch and place the soldering copper on when he starts to make the splice it will be hot when he gets ready to solder and the job can be completed in about the same time as the sleeve connection. Of course I mean a modern blow torch and not one of the old obsolete worn out ones which some companies require their men to use. Considerable improvement has been made in blow torches during the past few years. However, either the sleeve or the soldered connection will be satisfactory if properly made.

One of the most common faults in drop wire splicing is that of not splicing each conductor even. When this is done the weight comes on one conductor which will stretch until some of the strain comes on the other or it will break. This common fault can be avoided by just a little precaution and care in equalizing the splice. If care is taken to use small coils of wire on short drops the number of splices can be reduced to a minimum. But when it is necessary to splice be sure and splice well even though it may take a little more time because you will avoid trouble later on.

## FLYING STONE DAMAGES CABLE

Last fall a construction gang was busy preparing the route for a new highway near Monticello, N. Y. Occasionally they were obliged to blast away a particularly rocky portion of the country side. On one of these instances of rock-blasting, a flying stone struck a telephone cable stretched along a hill more than five hundred feet away.

The blasting and road building went on, and the telephone service was continued with no apparent difficulty.

Then came the Christmas holidays and wintry nights. And on such a night the citizens of Monticello and the surrounding neighborhood, complained that a buzzing sound over the wire prevented the transmitting or receiving of telephone messages.

Throughout that night and the following day linemen from the New York Telephone Company braved the snow and storm in quest of the trouble. Finally, on a little hill west of Bridgeville, N. Y., they found the portion of the cable which several months before had been injured by the piece of flying rock. Snow had caused the cable to become damp, with the result that a cracking, noisy wire made telephoning a tragedy instead of a joy.

## NEW CABLE BETWEEN SAN FRANCISCO AND LOS ANGELES

A new cable stretching 415 miles between San Francisco and Los Angeles was put into service by the Pacific Company in September. This cable, costing $10,000,000, will be able to carry a peak load of 26,000 words of telephone conversation each minute, together with private telegraph messages, programs for radio broadcast hook-ups, and thousands of electrical impulses operating telephone typewriters.

Eleven repeater stations have been installed with more than 6,000 vacuum tubes. Nearly 270 miles of the cable is underground, enclosed in fiber duct.

The new line is one of the most important sections in the Pacific Company's $30,000,000 cable which will ultimately connect Canada and Mexico in the next few years.—Long Lines.

## AN APT PUPIL

A man who had just purchased a parrot that refused to talk was determined to teach it at least one word. Going over to the bird, he repeated for several minutes the words, "Hello! Hello!" At the end of the lesson, the parrot opened one eye and answered drowsily, "Line's busy."

# Telephone Activities Abroad

**Dispatches from Foreign Countries Keep United States Telephone Men Informed Concerning Telephony of the World.**

### Siam Plans for Trans-Continental Service

Siam has no regular wireless telephone connection with outside countries, although several experimental conversations have been held directly between Bangkok and Java, Hong Kong, Manila, Berlin and Washington. London has also been reached, but this connection went through Berlin as the Department of Post & Telegraph has a working arrangement with the German Telefunken Co. for connections in England and other European countries. These connections have been made with the view to establishing a regular wireless telephone service between Bangkok and other principal cities of the world. Equipment for this service is now en route and will be installed as soon after arrival as possible. The latest long distance connections were made on October 17 and 18 when very clear conversations were held with Washington, D. C., and Berlin. In the Washington test the Siamese Legation was called by ordinary telephone. The Berlin connection on October 18 was likewise very satisfactory, some of the local foreign residents participating.

### Telephone Receipts Decline in the Netherlands

Combined receipts from the Netherlands postal, telegraph and telephone services for the first 10 months of 1930 totaled 66,153,002 florins (one florin equals $0.4020) or 949,331 florins less than the estimates and 958,119 florins less than actual receipts in the period January to October, 1929.

### Citizens of Java and Australia Converse

Wireless telephone communication between Australia and Java is expected to be established at an early date. Preliminary conversations have been held to discuss charges and technical details, according to The Electrical Review.

### Telephone Service Planned Between United States and Bermuda

Application has been made by the A. T. T. for a construction permit to erect stations for a short wave radio telephone service between the United States and the Bermuda Islands. In Bermuda the service will be handled by the Imperial & International Communications, Ltd., working in conjunction with the Bermuda Telephone Company. Plans call for the construction of transmitting station at Lawrenceville, N. J., with the receiving station at Netcong, N. J. The transmitting and receiving stations of the Imperial & International Communications, Ltd., will be located in the vicinity of St. Georges and Hamilton, respectively, where connection to the island telephone system will be made.

### Denmark Plans Improvements for Foreign Telephone Connections

A new telephone cable will be laid across the sound between Malmo, Sweden, and Copenhagen, Denmark, according to current press reports. It is stated that the increasing telephone correspondence between Denmark and Sweden, due in a large measure to the lower rates, makes such a move necessary. Furthermore it is the logical consequence following the laying of the new line between Malmo and Stockholm in 1931. It is said that the approximate cost of the projected cable will amount to 1,500,000 crowns (one crown equals $0.2680). There are at present many telegraph cables between the two points, but only one telephone cable. The above mentioned cable is but a part of the program being advocated by the Post and Telegraph administration whereby the sum of 4,000,000 crowns is being sought for an extensive improvement of the telephone connections with several European countries, the chief lines being those to Paris, Berlin and London.

### Suggests Laying Telephone Cables in River Thames

The port of London lags behind several of its British and foreign rivals in the facilities provided for ship-to-shore telephone communication, in the opinion of H. Willoughby Lovell, the Admiralty Marshal, who suggests that telephone cables should be laid to the principal buoys in the River Thames for the convenience of vessels lying in the river.

Direct ship-to-shore connections have lately been established at Cardiff, Swansea, and Newport, and on the Tyne a number of berths have installations which make it possible, on the arrival of a ship, to place a portable telephone on board. He suggests that savings of time and money would be effected if cables were laid to buoys in the Thames.

### Cancellations Exceed New Subscribers in Australia

Figures released recently by the Telephone Branch of the Postmaster General's Department reveal the fact that the number of telephones disconnected in recent months has exceeded new subscribers. In July, 1930, there were 595 more cancellations than new subscribers, in August the number was 836, September 1,201, and October 1,342. In October there were 3,007 new telephones connected and 4,349 disconnected. The cancellations are attributed to the fact that business houses are cutting the number of their lines to a minimum and private individuals are economizing by dispensing with telephone service, while in addition, a number of suburban shopkeepers are going out of business.

### Work Started on Greek Telephone Concession

Recently the city of Piraeus celebrated the laying of the foundations of the new telephone exchange building which is to be erected in that city under the terms of the concession recently awarded by the Greek Government to the German company, Siemens & Halske, Berlin. Similar buildings are also to be constructed in several of the other larger cities, where the present telephone housing facilities are not adequate. In the city of Athens the site of the building has been plotted out and excavation work is under way. It is expected that by the end of 1932 most of these buildings will be ready to receive the new telephone installations.

### Government Telephone Service in Finland

The Finnish Government's telephone service is entirely long-distance and international. No local connections are made. It competes in certain instances with the Finnish Interurban Telephone Co. During 1929 and 1930 much work was done to expand and improve the Government's telephone service.

International telephone traffic, a comparatively new development in Finland, has also increased steadily. Three-minute units from Helsingfors to cities abroad increased from 5,942 in January, 1930, to 8,538 in October, 1930. Most active traffic takes place with Sweden, with which 5,003 three-minute units were had during October. Estonia and Germany follow in order. Finland has telephone connections with North American countries, Cuba, Mexico, and Australia by way of London and with South American countries by way of Berlin. Due to the expense of telephoning to transoceanic countries, however, such traffic does not exist in practice with the exception of a few calls to the United States.

Col. H. W. Cleaver, commercial manager for the local exchange of the Ohio Bell Telephone Co., at Xenia, Ohio, was awarded an emblem in recognition of thirty years' service in the telephone exchange. He began as a lineman at Lebanon, Ohio.

# Open Wire Systems Simplify Broadcasting

**Technical Problems Encountered in Designing Repeater Equipment and Loading for Program Circuits Are Similar to Those Met in Designing Channels for Ordinary Telephone Purposes According to R. A. Leconte, in Charge of Toll Systems Development for the Bell Telephone Laboratories.**

With the development of radio broadcasting there arose a demand for facilities to link together several broadcasting stations by wire networks so that the same program could be broadcast simultaneously from widely spaced centers. As a result, certain long-line circuits of the American Company have been made available for this service and are known as program networks. Six open-wire systems are in use at present and over more than 30,000 circuit miles link upward of 150 stations together. Cable circuits are also being added to the existing open-wire chains, thus putting the long-lines facilities of the Bell System still more fully at the disposal of national broadcasters.

Technical problems encountered in designing repeater equipment and loading for program circuits are similar in general nature to those met in designing channels for ordinary telephone purposes. For each of these types of facilities the circuit of course must be designed so that an electrical impulse impressed at one end will be reproduced sufficiently well at the other to serve the purpose of the circuit. When the signal is considered as composed of sine waves of various frequencies and amplitudes, the requirements for ideally faithful transmission may be stated as follows: First, the component waves must be of the same magnitude relative to each other at the receiving as at the sending end. The overall attenuation, in other words, must be independent of frequency. Second, the components must be in the same time relationship at both ends; that is, the speed of travel over the circuit must be the same for all frequencies. Finally, only the components present at the sending end should be found at the receiving end. This means that the transmitting system should be free from outside interference, and that it should not give rise to new components—either harmonics or combinations of the original frequencies.

It is, of course, not possible nor necessary to provide ideally faithful transmission for either telephone or program circuits. For the former type of facility the object is to convey a spoken message which may be interpreted clearly and easily and with a reasonable amount of naturalness. For this purpose it has been found satisfactory to transmit a band of frequencies of about 2,500 cycles, this band being from about 250 cycles to 2,750 cycles for present standard designs.

For program transmission, on the other hand, more is required of the circuit than for message transmission, for here naturalness is considerably more important and it is necessary to transmit a wider band of frequencies; first, for the reason that increased naturalness requires the wider band, and second, that the energy of musical instruments is not as likely to be habitually restricted to a given part of the possible frequency range as is that of speech. In listening to transmitted music one wants to receive the same impression that comes from listening directly to the music. It is desirable to recognize the various musical instruments with their different tone qualities, caused by the overtone combinations which accompany the fundamental notes. Even when the program is speech, more than intelligibility is wanted, since it is desirable to transmit the speaker's personality, as conveyed by the intonation and warmth of his voice.

For program circuits which make use of open wire conductors, this wider frequency band is obtained by providing the necessary amount of equalization for the wire line and making use of repeaters and associated equipment normally used for message circuits but modified to transmit the wider band for program use. Open wire circuits, now almost universally operated on a non-loaded basis, have inherently such transmission characteristics that by means of a small amount of attenuation equalization they may be made to transmit uniformly a fairly wide band of frequencies. Phase distortion has been found to be serious only for the longer circuits and is introduced chiefly by the repeaters and other equipment in the circuit. This effect has been reduced to a tolerable degree in the latest type of open wire program equipment by changes in design rather than by the use of phase correctors, as discussed below in the case of cable circuits. Modulation effects are likewise not experienced for the wire lines themselves, but are, of course, present to a small degree in the loaded entrance and intermediate cables and equipment.

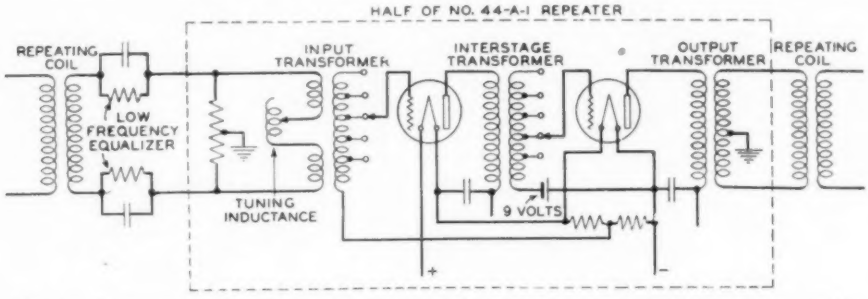



*Fig. 1. Repeater and associated apparatus for program transmission on open-wire.*

The four-wire repeater, consisting of two independent one-way amplifiers mounted on the same panel, can readily amplify a band sufficiently wide for program transmission. It is normally provided with a tuning arrangement of the input transformer so that its frequency-gain characteristic can be adapted to the frequency-loss characteristics of the various circuits with which the repeater is used. An adjustment of this tuning was made which increased the gain of the repeater at frequencies above a thousand cycles in correspondence with the increase in line loss. Below a thousand cycles the gain of the repeater more than compensates for the line loss so that to meet the requirement of equal over-all gain for the entire transmitted band, additional loss was required for the lower frequencies. This was obtained by inserting a network in series with the repeater, which consists of a condenser shunted by a resistance. Figure 1, a schematic circuit of the repeater and associated apparatus for open-wire program circuits, shows this low frequency equalizer connected on the receiving end of the wire section.

As the cable networks became rapidly extended, their greater reliability made it desirable to use them also for the transmission of programs. Although the open wire circuits are readily adapted to this special use, cable circuits require more fundamental modification to make them suitable for the transmission of

wide frequency bands. Cable pairs used for long distance telephony are loaded to reduce their attenuation by the insertion of inductance coils at regular intervals. This loading makes the transmission characteristic of the cable circuit somewhat similar to that of a low-pass filter, so that when a frequency approaching the nominal cut-off value is transmitted, its attenuation becomes very great. This cut-off point for the highest quality cable circuits used for message transmission,

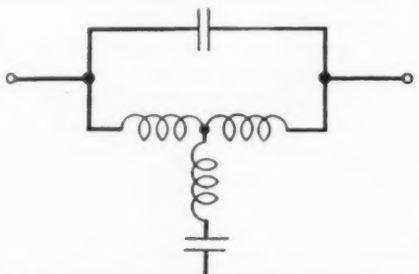


*Fig. 2. A delay equalizer network for B-22 cable circuits.*

which employ H-44 loading (44 millihenry coils inserted every 6,000 feet), is about 5,500 cycles, and it is not practicable to equalize such circuits over long distance to transmit frequencies much above 4,500 cycles. Since this frequency limit was not considered high enough for the expected future requirements of program transmission, the B-22 loading system was developed which uses 22 millihenry coils inserted every 3,000 feet. This halving of the inductance and of the capacitance of the cable between loading points, results in a doubling of the nominal cut-off frequency which becomes 11,000 cycles and permits equalization for frequencies up to 8,000 cycles.

The transmission of a wide frequency band over cable circuits is also affected by the speed of transmission, which is considerably lower for loaded cable circuits than for open wire. Were the

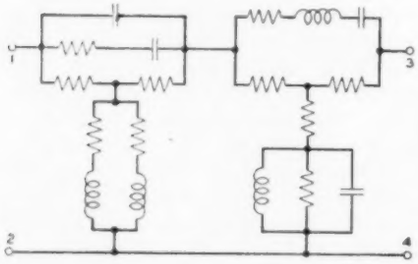



*Fig. 3. Attenuation equalizer for B-22 cable circuits used for program transmission.*

speed the same for all frequencies, no troubles would arise, but unfortunately the higher frequencies are delayed more than the lower, and over long distances the differences can be detected by the listener. The high frequencies, which arrive last, also remain after the lower frequencies have died out and give rise to a transient effect which at times may be seriously damaging to the quality of the program.

It is necessary, therefore, to introduce correction, not only to compensate for attenuation distortion but for the unequal speeds of propagation as well. To accomplish this, a phase corrector is associated with the repeater, which introduces a greater delay at the lower frequencies. Figure 2 shows the nature of the network employed. Component frequencies transmitted over the line and network together are delayed the same amount to within a few milliseconds for a 2,000 mile circuit.

Because of the greater attenuation of cable circuits, repeaters must be used at much closer intervals than for open wire circuits, and are located about every 50 miles. There are a greater number of repeaters, therefore, and equalization of each repeater must be made with greater accuracy. Instead of attempting to shape the repeater characteristics to compensate for the line attenuation-distortion, the repeater is designed to give a constant gain over the desired frequency range, and a special equalizing network is associated with the input of the repeater, to equalize the line characteristic.

Because of the high attenuation of cable circuits, the variation of attenuation with temperature is considerable and occurs at a rapid rate which requires automatic correction. When such regulation was considered for program transmission it was found that the wide frequency band transmitted introduced a peculiar attenuation problem. For frequencies up to about 5,000 cycles an increase in temperature caused an increase in attenuation due to the increase in the resistance of the line. Above 5,000 cycles, however, the effect was reversed. An increase in temperature caused a decrease in leakage conductance which became predominating at the higher frequencies. Such a reversal of effect, of course, greatly complicates the problem of equalization since the gain of the repeater must be varied in opposite directions in different parts of the transmitted band.

To obtain suitable equalization a network is attached to the ordinary repeater at regulating points. The repeater is surmounted by the regulating network which includes an additional tube and, inserted

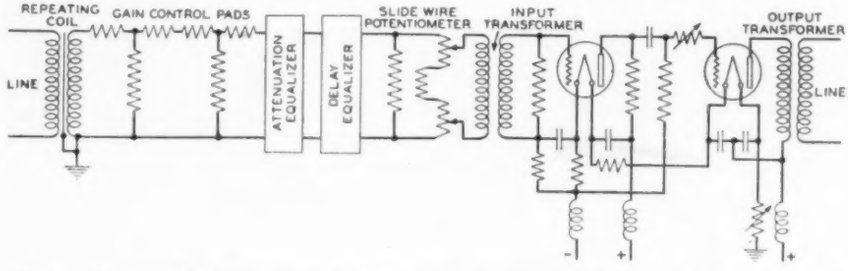



*Fig. 4. Non-regulating repeater and associated apparatus for B-22 cable circuits used for program transmission.*

This network is shown in Figure 3, and the repeater circuit in simplified form in Figure 4.

As may be seen from this diagram, the repeater itself introduces both shunt inductances, in the form of transformers, and series capacitances, which decrease the speed of propagation for the low frequencies more than for the high. Fortunately the ear is less sensitive to low-frequency delays than to high and perfect equalization does not appear necessary. There is a maximum value of delay which may not be tolerated, however, and a delay for each repeater of not more than one millisecond at 50 cycles has been found unobjectionable. This low delay is obtained by the use of a repeater circuit of high grade coils with permalloy cores and high inductance values. In addition the series capacitances are made large in comparison to the impedance of the circuit in which they are inserted, and a pure resistance coupling is employed between the two stages, which avoids the additional shunt inductance which would be present were the plate of the first tube fed through a retardation coil.

as an interstage coupling, a shunt-type potentiometer together with variable resonant shunts.

## A NEW INVENTION

A small boy had watched a telephone repairman climb a pole, connect a test set and try to obtain connection with the test board. There was some trouble obtaining the connection. The youngster listened a few minutes and rushed into the house, exclaiming, "Mama, come out here quick. There is a man up a telephone pole talking to Heaven."

"What makes you think he is talking to Heaven?"

"'Cause he hollered, 'Hello! Hello! Hello! Good Lord, what's the matter up there, can't anyone hear?"

---

New automatic telephone service completed at Marshall, Minn., by the Tri-State Telephone Co. Over $131,000 outlay made for additional plant investment.

# Simple Rules to Follow in Locating Trouble

**Ernest Wommack Explains Several Tests Which Will Help the Wire Chief Discover Whether the Cause of Difficulties Lies in the Central Office Equipment or Outside; Information Given Here Should Save Telephone Men from a Good Deal of Bafflement Regarding Line Trouble from Now On.**

When the wire chief receives a C. G. C. report he doesn't immediately know whether the trouble is in the central office equipment, or outside. A continuity test may indicate a complete circuit through the subscriber's instrument in spite of the fact that the transmitter circuit might be open or the line lamp burned out, either of which would cause the trouble.

A definite way of determining whether such trouble is in central office equipment of central energy type which has been found practical, is by using the 0-30 volt scale of a No. 280 Weston voltmeter with its corresponding 0-100,000 ohms resistance. It is thus possible to discover opens, dirty contacts, or loose connections. At the same time the internal resistance of the No. 280 voltmeter is so high that when thrown across the line it will not energize the line relay and therefore will not signal the operator.

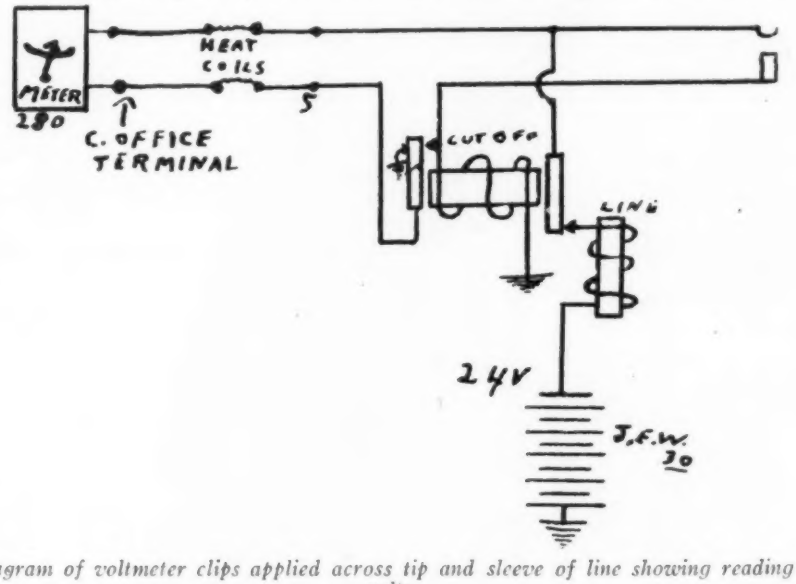



*Diagram of voltmeter clips applied across tip and sleeve of line showing reading of volts.*

By referring to the drawing it is readily seen that by applying the voltmeter clips across the tip and sleeve of the line there should be a reading of between 21-24 volts under normal conditions (depending upon plant battery voltage, voltage drop across terminal leads, and resistance of line relay coil winding). This voltage will vary under different conditions and types of equipment.

To determine normal voltage for a particular type of equipment several units may be selected at random from the main frame and the voltmeter clips applied to the terminals of these various units. If the reading is, for instance, 21 volts in most cases, 21 volts may then be taken as normal voltage on this test. Any undue variation from this voltage during subsequent tests will indicate loose connections, dirty contacts, open line relay coil, or high resistance heat coils.

This simple test is of great benefit when made from the distributing frame at point of cable connection. By testing from cable side of the distributing frame the test is made through main frame jumper and its soldered connections, through protector, through cable from protector to relay rack, and from there to contacts of cut-off relay and through winding of line relay.

In brief a test is thus made through all central office line equipment including line relay but not taking into consideration line lamp signal, etc., since suitable testing facilities are usually provided by manufacturers and incorporated in switchboard design for this purpose. In addition this test brings to light high resistance heat coils, and where a particular type of heat coil, which we have in mind, is used (using a composition or carbon resistance instead of a wire wound resistance) many cases of high resistance are found by this method. Wherever this type of heat coil is still used unsatisfactory conditions are present but not always evident.

Some of the results from high resistance heat coils are unbalanced lines, spasmodic intervals of C. G. C. and for the most part poor transmission. The best way to correct this trouble caused by carbon filled heat coils is to make a wholesale replacement with wire wound, low resistance heat coils. Where the expenditure is greater than the management can make at one time the next best remedy is to keep a sufficient supply of new heat coils on hand at all times whereby replacements may be made as the old type heat coils go completely bad.

With the voltmeter placed across the cable side of the distributing frame terminals of the line under test heat coils may be quickly tested by shorting around the heat coils one at a time. Any decrease in resistance during the shorting interval indicates the amount of resistance in the heat coil. Through such tests we have found heat coils measuring from 10 ohms to open or infinity.

One more reason for our belief in this method of testing is that without some knowledge of conditions we are very likely to "knock off" cases of trouble which are working on a hair-trigger margin and are ready at the slightest touch to leave and give us a good line, which results in some baffled and useless deep thinking. For example, cut-off relays stick sometimes and when we start to remove the relay shell of the line in trouble we are apt to cause the armature to release and our trouble is gone only to return another time and give a subscriber good cause for another report of "The operator can call me but I can't call central half of the time." We've all heard that music. Music? Sometimes it's static!

---

### BETTER THAN ARGUMENT

Telephone linemen began digging holes across a German farmer's lawn. He remonstrated, but they showed him a paper, their authority from the court, they said. Without a word the farmer went to the back pasture gate, opened it and soon a huge, red bull came tearing down the road sending the linemen over fences and up into trees.

"Hey! Wat's the big idea?" yelled the foreman. "Get that cussed bull outa here!"

"Vell, vot's da matter now?" shouted the farmer from his porch. "Vhy you dont show him dot paper?

# For thos

"We cannot affo
unacquainted w
heavily year af
expenses are oft
for them to pay
would leave a he

It is true tha
carries out the fu
capital investme
times led to beli
ture for local tr
but also highly a
the one means
definitely assured

The newly
munities, from a
you Bulletin 155
one of our sales
of course.

STROWGER AUTOMATIC
DIAL SYSTEMS

GENERAL EXPORT DISTRIBUTORS
The Automatic Electric Company, Ltd., Chicago

*In Canada* . Independent Sales and Engineering Co., Ltd., Vancouver
*In Australasia* . . . . . Automatic Telephones Ltd., Sydney
*In Japan* . . . . . Automatic Telephones Ltd. of Japan, Tokyo
*In China* . Automatic Telephones of China Federal Inc., U. S. A.

STROWGER A
Factory and

# those who "CAN'T AFFORD" DIAL EQUIPMENT

"We cannot afford dial equipment," is a familiar plaint of telephone men unacquainted with Strowger economy. Yet these same men "invest" heavily year after year in traffic expense. In fact, their operating expenses are often so high that dial operation would not only save enough for them to pay the added carrying charges on the new equipment, but would leave a healthy surplus for profitable operation besides.

It is true that Strowger Dial equipment, since it entirely replaces and carries out the functions of the local operator, does necessitate increased capital investment (not as great, however, as telephone men are sometimes led to believe)—but the elimination of the heavy, yearly expenditure for local traffic makes its adoption not only economically feasible, but also highly advisable. It offers to small exchanges as well as large, the one means by which present and future profitable operation is definitely assured.

The newly developed Type 51 exchanges are ideal for small communities, from a few telephones up to several hundred. May we send you Bulletin 1551 describing them in more detail? Or better yet, let one of our sales engineers prepare a proposal for you, without obligation, of course.

**Automatic Electric Inc.**

*Manufacturers of*

STROWGER AUTOMATIC DIAL TELEPHONE AND SIGNALING SYSTEMS

Factory and General Offices: 1033 West Van Buren Street, Chicago, U. S. A.

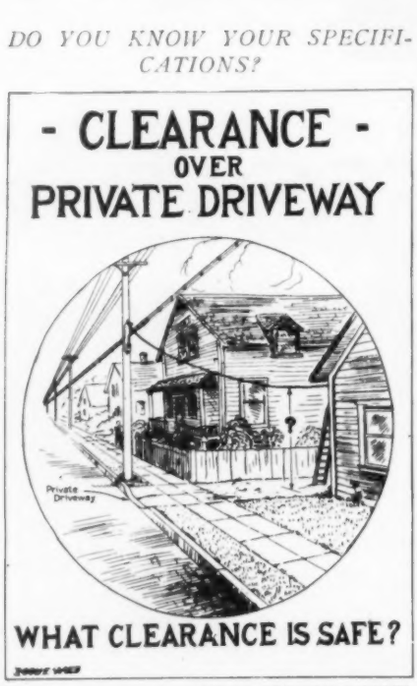
*Sales and Service Offices in All Principal Cities*

ASSOCIATED COMPANIES

American Electric Company, Inc. . . . Chicago
International Automatic Telephone Co., Ltd., London
Automatic Telephone Manufacturing Co., Ltd., Liverpool
The New Antwerp Telephone and Electrical Works . . . . . Antwerp

# LINE AND DESK — HELPFUL HINTS FROM HERE AND THERE

*DO YOU KNOW YOUR SPECIFICATIONS?*



*These problems are becoming more interesting. Are you still batting one hundred per cent? The above should be very simple; see how well your co-workers are posted. Watch next month's issue for the answers.*

(Editor's Note.—These problems are published through courtesy of the California Independent Telephone Association, and answers are provided according to California Railroad Commission orders. There is sometimes a slight variation in telephone rulings of different states, due to differences in population, highways, typography, and climate. Therefore the answers to these problems as published here may not coincide exactly with the answer which would be correct in your state. However, any variation will be slight. The California rulings were chosen as most generally applicable.)

---

*DO YOU KNOW YOUR SPECIFICATIONS?*

The answers to last month's problems, appearing on page 52 of the January issue, are:

No. 1. Service Drops Below Transformer.

Service drops supported on guard arms must have a clearance of 40 inches below transformer. If service wires are supported on brackets attached directly to the pole, the clearance must be five feet. Where the cross arm braces supporting the lower supply arm on which the transformer rests are attached at less than one inch from the transformer, case or hangers, the service wire clearances shall be measured from the lowest point of the braces.

Unguarded cables below transformer shall have a clearance of six feet.

Guarded cables below transformers associated with supply circuits of more than 7,500 volts shall have a clearance of six feet. Where supply voltage is 7,500 volts or less, the clearance may be reduced to four feet. These clearances must be measured from the lowest point of the cross arm braces if these are attached to the supply arm at less than one and one-half inch from the transformer, case or hangers.

No. 2. Climbing Space.

Guarded cables below supply circuits shall have a clearance of four feet. Service drops distributed from guard arms shall have a clearance from supply conductors of 48 inches. This latter clearance may be reduced to two feet under circuits of up to 750 volts, if necessary to secure greater clearance over a crossing, providing wires are supported at least 25 inches from the center line of the pole.

The distance between attachments on opposite ends of the guard-arm shall be 30 inches and service wires shall not cross the 30 inch square climbing space which extends at right angles to the guard arm, and has the guard arm for one of its sides. The climbing space shall not be rotated more than 45 degrees between any two conductors.

---

*DISTILLED WATER*

Telephone companies sometimes encounter difficulties in securing pure distilled water with which to replace the evaporation in storage batteries. This water is usually obtained from the local ice plant at a cost of from five to ten cents a gallon.

Although the water is distilled, it sometimes is of doubtful purity. Bacteria is thoroughly destroyed, but chemists of an ice plant seldom make any effort to elim-

*ANALYSIS OF TELEPHONE SERVICE*

| | | |
|---|---|---|
| Adequate Telephone Plant | Good Telephone Transmission | Loudness<br>Quality<br>Freedom from interference<br>Education of public in regard to necessity for good equipment. |
| | Adequate Facilities | |
| | Simplicity of Substation Equipment | |
| | Reliability of Equipment | |
| | Safety | |
| | Permanence | |
| Effective Telephone Operation | Accuracy | |
| | Continuity of Service and Reliability of Operation | |
| | Speed | |
| | Assurance of Attention | |
| | Courtesy and Form | |
| | Secrecy | |
| | Service Inspection | |
| | Education of Public in Regard to Use of Telephone | |
| Good Management | Business Methods | Accuracy<br>Promptness<br>Simplicity |
| | Financial Policy | Adequate depreciation reserve<br>Adequate surplus<br>Adequate rates<br>Proper control of securities |
| | Care and Training of Employees | |
| | Citizenhip | Progressiveness<br>Appearance of plant<br>Regard for rights of public<br>Local interest and cooperation |
| | Publicity | Condition of plant<br>Methods of operation<br>Service objectives and results obtained<br>Reasons for rates |

Clip the above chart, and use it to check up on your own plant. Your product is service, and you should make certain it measures up to the modern, present-day standard.

inate certain minerals, which although not injurious to health, are harmful to storage batteries. Since water from an ice-house still is often placed in a large iron tank, rusty from continuous use, it is little wonder when the water contains quantities of iron. The addition of impure water to a battery over an extended period of time will cause an accumulation of impurities in the battery cells, from which a loss in the capacity of the battery will result.

This difficulty can be avoided by the use of a small water still, heated either by gas or electricity, of which there are several types now on the market. These small stills can be purchased at a reasonable price and will make possible the manufacture of pure distilled water at a cost of approximately one cent a gallon or less. One exchange has reported that a gas heated still paid for itself in six months following its installation in the saving made on each gallon of distilled water previously purchased at ten cents a gallon from the ice company.

In addition to the economy resulting from the use of a private still there is the satisfaction of knowing that the distilled water is absolutely pure and can in no way damage that all-important part of the telephone exchange.

### *A FEW WORDS ON GROUND RODS*

Particular attention should be given to the ground rod when grounded lines are under consideration. Too often this ground rod is of inadequate size and improper material.

For the best results, this rod should be six feet long and one-half inch in diameter, and made of hot galvanized iron. It should be driven into permanently moist earth. Where the climate is dry or prone to suffer prolonged dry seasons, a galvanized pipe one inch in diameter is preferable for the ground rod, as it can be filled with water and plugged to prevent evaporation, thus insuring good results regardless of weather conditions or climate.

In attaching the ground wire to the ground rod, a tight twist is preferable to a poorly soldered connection. Before a ground rod can be soldered it must be heated until the solder will run freely, otherwise it will merely mold around the cold rod, resulting in the poorest kind of joint. One of the best methods of soldering is to submerge the joint in a pot of molten solder until hot, then remove it, rapidly flux the joint, and pour on the molten lead with a ladle.

Ground rods already in service can easily be pulled up if they are first bent over and twisted until the surrounding earth becomes loose. Previously soldered rods can then be substituted in the places where the old ones were extracted. After a number of old rods have accumulated they can be soldered in the shop. Thus there is no waste and these rods can be used again.

If the old ground rods are left in service, use a tightly twisted connection of No. 12 wire, as a strong blow-torch is required to heat a ground rod in service so that a good "wiped joint" can be secured.

### *IMPORTANCE OF SUBSTANTIAL CORNERS*

Almost any old snags will support the straightaway sections of a line, providing the corners are good ones and well guyed.

It is almost impossible for joints in first class iron wire, used in the country open spaces, to develop high resistances or cutouts, providing they are kept under strain. One of the fundamental requirements of all toll and country lines is that splices and joints be kept under strain.

If the corners are improperly guyed or begin to sag, any joints or splices in the line are certain to develop trouble, which is usually most difficult to locate. Make sure your corners are built for permanence.

### RELAYS INVOLVED IN INCOMING TRUNK CIRCUIT

(*Continued from page* 17)

the distant office cord circuit which furnishes the current to operate the number one relay of the trunk circuit. The coil is shown in this way for the sake of simplicity. The real function of the "A" or distant office battery supply relay was described in the issue of TELEPHONE ENGINEER in which the installment entitled "'A' Office Circuits" appeared.

In the circuit diagram, shown in connection with the common equipment, the relay marked "X" shown operated is the low wound relay in series with the "B" operator's primary or transmitter circuit. It operates only when the "B" position is occupied by the operator, which in turn operates the numbers 28 and 29 relays which were described in the January issue of TELEPHONE ENGINEER.

The portion of the trunk circuit shown in the diagram shows the incoming trunk lamp, which will be flashing due to the reciprocating action of the ABC and D relay. These relays are shown in an operated position ready to release in progressive order, and when they all release the lamp will light and then go out.

Along with the lamp circuit are the operations of the peg count or meter circuit and pilot lamp. The circuit of the first impulse of the call passing tone is shown. The break in the tone circuit and the restoration of same is rather difficult to show in its complete operation, but the operation can be noted by tracing the complete circuit and its description in a previous issue.

The operator's circuit is not cut in during the procedure as shown but it is in a position to receive a small amount of the call passing tone through the small condensers and to be cut in direct a fraction of a second later when the final tone relay operates.

There are more relays in the common circuit that operate when an incoming call is cut in. These relays will not be shown at this time because of the confusion that may possibly arise when one is tracing out the circuit operation of the incoming lamp circuit and its auxiliaries.

The reader is kindly asked to refer to the individual relay descriptions previously published, because repetition of a great amount of descriptive data can be eliminated in describing the operation of portions of the circuit.

## Climbers

**By Ray Blain**

They are known as spurs annd hooks and climbers. But regardless of what they are called they are as necessary to a lineman as a life belt to a sailor. When one considers the dependence a lineman must place in his spurs, it is hard to understand why some continue to use them long after the gaffs are worn to a point where they cannot be considered safe.

In many cases linemen will wear spurs of improper shape and length which is a cause of continual annoyance and torment. Any lineman will tell you with emphasis that sore legs are no fun. Good spurs have a flexible shank which will yield readily to the pressure of the leg and do not chafe as is inevitable when the shank is rigid. The gaff or spur should be of correct shape and set in the shank at the proper angle so that there is no danger of them cutting out of the pole regardless of the lineman's position.

Tree hooks with extra long gaffs are a great convenience for tree trimming. These hooks are the same as the ordinary type except they have gaffs about five inches long in order to penetrate any kind of mark and reach into the firm wood where they will hold. The ordinary short gaff is dangerous on trees as they tear out of the bark, mar the trees and are likely to be responsible for serious injury to the lineman. Tree trimming at its best is not an easy task for a lineman.

Straps on climbers should be kept in good condition at all times in the interest of safety. A good pad should be provided for the climber as it does much to absorb the shock where the top of the shank bears on the leg.

## News From the Field

The Michigan Bell Telephone Company has planned an expenditure of approximately $22,000,000 for new construction during 1931, according to President Burch Foraker. In addition, approximately $22,689,000 will be spent for maintenance and operation of the company's service in Michigan, he said.

---

A construction program amounting to $10,100,000 for 1931 has been outlined for the Southern New England Telephone Company according to a recent announcement by company officials. This sum is 12 per cent greater than the average annual amount spent for construction during the last five years.

---

Word has been received of the death of William Hayes McMahan, 54, of Marion, N. C., president of the Marion Telephone Company and president and owner of the Blanton Feed Company.

---

The five-day week has been adopted by the Wisconsin Telephone Company and is now in effect according to John O'Day, vice-president. Some 1,300 central office operators and 600 employes of the plant department are working 40 hours each week instead of 48. Pay is for 40 hours. This plan was adopted rather than cutting salaries or reducing the number of employes.

---

An expenditure of $10,000 for improvements and extension on telephone lines in suburban districts has been authorized by the telephone company in Wheeling, W. Va.

---

A telephone directory of the entire United States, published in 1897, has been unearthed by a resident of Dover, N. J., from among old family possessions. New Jersey has but 47 pages in the volume, listing only about 4,000 subscribers. There are about 750 pages in the entire "National Telephone Directory" with less than 200 listings to a page. The volume includes all of the New England states, New York, New Jersey, Pennsylvania, the seaboard as far south as Virginia, and west to the Dakotas and Arkansas.

---

Workmen are in the process of rebuilding the telephone exchange at Afton, Ia. Following completion of the outside work, a new switchboard will be installed at the central office.

---

The New York Telephone Company spent approximately $100,000,000 for plant additions in 1930, according to a late report. This was only slightly less than expenditures in 1929, which were the largest in the company's history. Two-thirds of the 1930 aggregate was expended in New York City.

---

Instantaneous warning is given whenever there is a break in the cable of the new trans-continental telephone cable under construction by the North Western Bell Telephone Company between Omaha, Council Bluffs, and Chicago. This is made possible by nitrogen gas, under pressure, placed into the line. If a break should occur, pressure gauges at repeater stations will show approximately where the break is located.

---

Possible construction of a second trunk line between United States and Mexico was discussed recently by W. F. Flanley, vice-president of the Mexican Telephone & Telegraph Company in conference with officials of the Southwestern Bell Telephone Company.

---

Permission has been granted the New York Telephone Company by the state public service commission, to acquire the rural Schenectady, Delanson and Esperance Telephone Company, which entire system serves only 237 subscribers.

---

The Wisconsin Telephone Company will start soon on construction of a new long distance cable between Stevens Point, Wis., and Appleton, Wis.

---

Sale of the Acme Telephone Company of Bloomville, O., to the Ohio Standard Telephone Company of Columbus has been announced.

---

The new $100,000 building of the Standard Telephone Company, Dalhart, Tex., was dedicated with formal ceremonies recently.

---

### SOUTH DAKOTA TELEPHONE MEN CONVENE

Delegates to the 25th annual convention of the South Dakota Telephone Association, held at Sioux Falls, S. D., January 13th, 14th and 15th, were urged to concentrate on selling telephone service.

The importance of this department of the industry was emphasized by two different speakers who addressed the convention, namely, M. L. Densmore, assistant general manager for the Central West Public Service Company who spoke on "Is the Telephone Industry Keeping Pace With Other Industries?" and John H. Agree, general manager, Lincoln Telephone and Telegraph Company, and a director of the United States Independent Association, whose subject was "Maintaining the Prestige of the Telephone Company."

Both said they believed telephone people did a mediocre job of selling service, as compared with the job done by those active in the automobile industry and the light and power industry.

Grant E. Preston, president of the state association, presided over the meetings held during the three days of the convention. In his annual address, which was the feature of the first day's program, he complimented the delegates on the number of district conferences held throughout South Dakota during the past year, and stressed the importance of continuing them. He said that through the medium of these district conferences, the South Dakota Telephone Association was taken to the small exchange companies and the rural companies, which were not financially able to send delegates to the state convention.

A. G. Burch, informational activities supervisor of the Northwestern Bell Telephone Company, Omaha, Neb., was a guest of the convention, and gave an illustrated lecture on "Trans-Oceanic Telephony".

Another guest was Roger Brown, city editor of the Sioux Falls Argus-Leader, who, when called upon for remarks, praised the class of telephone service provided by the Independent companies of the state, emphasizing his pleasure at the superior service rendered his paper last fall when election returns were being compiled.

Other speakers on the convention program were: T. H. Schroeder of the state highway commission; Leslie Jensen, collector of internal revenue for South Dakota, and secretary-treasurer of the People's Telephone and Telegraph Company at Hot Springs, S. D.; and M. J. Cronland, general auditor, Dakota Central Telephone Company.

Members of the board of directors elected at the convention were: Grant E. Preston, Ira S. Burnett, and W. W. Straight, all for one year; H. M. Schumacher, P. F. Orcutt, and Charles E. Adams, all for two years; and F. R. Irons, W. A. Bruzell, and D. T. Patterson, all for three years.

Following the close of the general convention the board of directors met and chose the following from their number as officers for the ensuing year: H. M. Schumacher of Alexandria, president; F. R. Irons of Woonsocket, senior vice-president; and P. F. Orcutt of Custer, junior vice-president. Thomas Phalen was chosen secretary-treasurer.

---

### HEADS RADIO ENGINEERS

R. H. Manson, vice-president and chief engineer of the Stromberg-Carlson Telephone Manufacturing Company, was elected president of the Institute of Radio Engineers at the annual session of the institute, an international body, held recently in New York.

# Practicing Economy in Carrier Operation

**Loading Coils Are Not Practical on Long Distance Lines When Repeaters Are Introduced, But Economical for Straight Toll Lines and Cables, Says F. J. Dommerque, Fellow A. I. E. E., in This Article, the Fifth of His Series for TELEPHONE ENGINEER.**

### Economical Use of Carrier

In modern toll and long distance work the expansion of the system takes place about as follows: For short distances of open-wire construction without repeaters the lines are loaded. Loading of long distance lines of open-wire is not practicable when repeaters are introduced. It was shown on the New York-San Francisco transmission line, when the originally inserted loading coils were removed and the repeaters doubled, that the efficiency of the line was not only improved but the transmission was made more uniform over a wide range of frequencies. Incidentally it was discovered that the removal of the loading coils brought with it greater independence of weather conditions.

Returning again to the short toll line without repeaters. The loading of such lines would be economical if it were certain that they would remain without repeaters, speaking now of open-wire lines; for cables loading is always the proper thing. In open-wire lines their series inductance keeps the distortion down, but in cables inductance has to be introduced to obtain a reduction of distortion. It is also cheaper to load cables than to increase the number of repeaters, which would be necessary to make up for the attenuation losses.

We still are speaking of straight lines and not of carriers. Since the use of repeaters makes it possible to use small gage cables for toll and long distance work, the use of toll cables has greatly expanded. But cables are more expensive than open-wire circuits, certainly when there is not sufficient traffic to warrant their installation. Therefore a thorough study has to be made as soon as the existing open-wire toll line between two points becomes no longer sufficient to carry the traffic and the stringing of new circuits is necessary. In this study many points have to be taken in consideration, of which we will mention the most important ones. First of all the existing toll line must be examined whether it is in a condition to warrant its further use for the application of carrier current. Next the cost of adding the apparatus for carrier current operation must be ascertained.

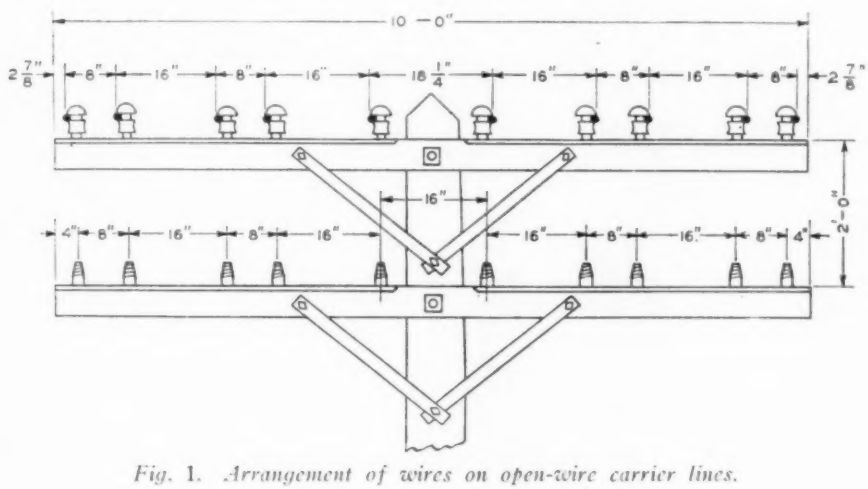



*Fig. 1. Arrangement of wires on open-wire carrier lines.*

Then the cost of the necessary transpositions has to be added. This is an important item as can be seen from Fig. 6 of the paper on Carrier Telephone System for Short Toll Circuits in the July, 1929, TELEPHONE ENGINEER. To the requirements stated in that paper may be added that on very long circuits the carrier channels require a reduction of the spacing between the wires on the crossarm from 12 to 8 inches to avoid excessive crosstalk. As only the wires in the pole pairs remain for phantom circuits, the gain in talking circuits by phantoming is reduced, which has also to be taken in consideration. The general configuration of such a pole line is illustrated in Fig. 1.

As mentioned in previous discussions for distances between 50 and 200 miles the type D carrier has been designed, giving one additional talking circuit. This type has been made economical by restricting it to one carrier channel and designing the equipment in the most compact manner omitting everything not absolutely necessary. For distances above 200 miles the type C carrier is used, giving three additional talking circuits. It must always be kept in mind that carrier systems are only economical as intermediate steps to toll and long distance cables, which may be overhead or underground cables.

### Entrance Cables for Carrier Circuits.

In all cities of any magnitude it has become the practice to bring the open-wire toll and long distance lines from the outskirts to the exchange in underground cables of special design, which has in all cases, whether the cables are loaded for voice currents only or also for the use with carrier currents, to conform to the requirements made on same with respect to avoidance of crosstalk and reduction of attenuation.

As far as cables for bringing in carrier currents is concerned, special care must be taken to avoid or at least bring to a minimum carrier crosstalk. It is a good rule to keep all conductors in the cable used for carrier operation to themselves, that is, separated from the conductors carrying voice currents only. This, however, can not always be done. The A. T. & T. Co. uses a carrier loading system designated as CE—4.1—12.8, having a cut-off frequency of 45,000 cycles and an attenuation loss of 0.22 TU per mile at 1,000 cycles. The cable, of course, is a loaded cable, which can be operated up to a frequency of 30,000 cycles or somewhat higher; that is, it can be operated to a frequency of from two-thirds or three-fourths of the cut-off frequency; its capacitance is 0.062 mf per mile.

On this loaded cable the loading coils require particular attention, not only as to their proper spacing, but also to their design feature. The theoretical spacing to be used with the type C system would be 930 feet, but in practice it is rarely possible to locate the manholes just at the theoretically correct points, usually the actual loading sections are made shorter and the deficiency in capacitance made up by so-called "stub cables," which are especially built for that purpose and are connected in shunt with the loaded conductors.

As to the attenuation losses in a carrier-loaded cable of No. 13 American

wire gage we give a table of data prepared by Shaw and Fondiller.*

| Frequency in kilocycles. | Attenuation loss in TU per mile Non-loaded. | C-4.1 loading. | Resistance in ohms per carrier loading coil. |
|---|---|---|---|
| 1 | 0.49 | 0.23 | 1.5 |
| 5 | 0.78 | 0.27 | 1.6 |
| 10 | 0.90 | 0.33 | 1.9 |
| 20 | 1.14 | 0.52 | 4.1 |
| 30 | 1.37 | 0.90 | 8.1 |

*Journal A. I. E. E., Feb., 1926.

As carrier currents are not operated over phantom circuits, the carrier frequency loading applies to the side circuits only. We will speak of the coils presently, but will first take up the matching of impedances.

### Matching of Impedances

Besides the entrance cables for open-wire carrier lines, we have intermediate cables, which have to be guided by the same rules as the entrance cables. It is necessary in order to obtain and maintain a uniformity of the electrical characteristics of the line to make the impedance of the cable approximately equal to that of the open line. If one part of a line differs in its electrical characteristics from the other part, we will have an unequal division of the current and consequently "singing." We have stated before the kind of cable which is to be used and its cut-off frequency and working frequency. It remains to state that the ordinary mid-coil and mid-section terminations will not easily assure a flat impedance frequency characteristic over the wide range of frequencies and that in such cases a special impedance corrective network of simple design may have to be installed at the terminals of the cables loaded for carrier current operation. In mid-coil termination of a coil-loaded line the first loading coil is placed at the beginning of the line, this coil, however, having only one-half of the inductance of the regular coils, the first of which is located at the end of the first complete loading section. In the mid-section termination the first loading coil is placed at a distance from the beginning of the line equal the one-half of a complete loading section.

### Carrier Loading Coils

As we have to deal with high frequencies and as there is danger from intermodulation between channels and from magnetic modulation it has been found necessary to introduce a special designed loading coil which is a toroidal coil with a wood instead of an iron core. To overcome, or at least to reduce to a minimum, Foucault or eddy currents finely stranded copper is used in the coil windings. If the carrier circuit is operated over the side circuits of a phantom, we have to distinguish between the coils placed in the side circuits and in the phantom audio frequency circuit. In the CE—4.1—12.8 loading system the coils in the side circuits then have an inductance of 0.0041 henrys, while the coils in the phantom circuit have an inductance of 0.0128 henrys. The assumed cable capacitance for the side circuits is 0.062 mf per mile and for the phantom 0.100 mf per mile. The spacing for the coils in the side circuits is 0.176 miles, in the phantom 1 mile.

### Toll and Long Distance Cables

Although great progress has been made in the construction and assembly of carrier current apparatus in units, so that they can easily be packed, transported, installed and moved from one place to another at any time when traffic and circumstances warrant a change to cabling the toll and long distance lines, it is not always advisable to install a carrier current system even if the preliminary estimates show a lower cost for their installation than for cables. It is necessary to make a development study which should cover at least the next five years and estimate the growth of traffic to be expected and the cost of the equipment to supply carrier lines on the one hand and cable on the other hand, taking in consideration all the items previously mentioned, also change in buildings or construction of new buildings; if then the scales weigh in favor of carrier current installation, it will be safe to proceed with it. In the western and southwestern United States there is still great opportunity for carrier operation, as the cities and towns are very far apart and many years will pass before the country is populated enough to warrant toll cables. In the east the opportunities are not so plentiful, therefore the toll cable mileage is growing rapidly and has passed 20,000 miles in the United States.

It, of course, always speaks in favor of toll cables, that damage and interruption of service caused by stormy weather, seasonal variations, external interference, etc., are decidedly avoided; but cables and their installation are still very costly, even taking in account that in modern times trenches are dug and filled in by machinery and cables are moved and handled by trucks with cranes and winches. Long stretches of cable have been carried on poles, so far instance the cable from Philadelphia to Pittsburgh. But the drawback of such installations is the variation in atmospheric temperature which influences the speech transmission, therefore the repeater gains and losses must be regulated automatically by the use of pilot wires in the cable.

### Buried Cables

In the United States the toll cables were installed first between the large cities along the Atlantic Coast. They were paper cables in lead sheath and were drawn into vitrified clayducts, as the large traffic between the cities warranted this rather expensive method. Where the traffic between the inland cities, and between inland cities and the cities along the Atlantic Coast, is not so heavy, the cost of such conduits becomes burdensome and in parts of the country where toll and long distance business is light, practically prohibitive. This brought up the question of cheapening the laying of the toll cables. There were two ways possible of doing this, either by using cheaper duct material or by burying the cable directly into the ground. Taking the first means, there were two kinds of duct material available, cement ducts and fiber ducts.

One of the first toll cables laid underground was the Berlin-Cologne cable in Germany, which was laid in cement ducts in the year 1921. The part Berlin-Hanover was completed before the world war, the remainder only after the war. Examinations after the cable was in service about 10 years, that is, 10 years after completion of the first part, numerous places of deterioration of the lead sheath were discovered and it was found that such deteriorations had taken place principally in regions, where the soil or ground water contained lime. Where the soil was free from lime, the cable was in fair condition, although by no means perfect. It appeared that at the points where the lead covering of the cable came in contact with the iron casings of the loading coils, which were placed in manholes about 600 feet apart, had formed a kind of galvanic element and caused corrosion. The only possibility to save the cable from total destruction was to connect to the lead sheath large zinc plates. As these plates could be used only in manholes it was only a partial remedy. Therefore the use of cement ducts was abandoned, as the material was too porous and would not sufficiently protect in regions where the soil contained lime.

Fiber conduit was never employed as duct material in Europe to the writer's knowledge, but had been and still is used in this country with success. Lately it has been applied here also in laying of toll cables.

After the bad experience with cement ducts in Germany the European engineers decided that in order to avoid contact of the lead sheath with water, it was essential to cover the cable on the outside with a coating impervious to water, in which case it would be safe to bury the cable into the ground. Lately this method of laying toll cable has also been tried in this country. The cable is protected by means of impregnated paper, jute and a steel tape covering. There are several layers of jute and tar and two servings of steel tape armor used. A trench is dug and the cable placed therein and covered up.

The fiber conduit promises to be successful, as it has been used so extensively in city conduit construction. Time will show how the employment of armored

# Warsaw, Indiana, Adopts Stromberg Board

**Kosciusko County Telephone Corporation Forced to Install Modern Equipment to Handle Increasing Toll Business—Center of Indiana's Playground.**
**By C. F. Sanders, Sales Engineer, Stromberg-Carlson Telephone Mfg. Co.**

Warsaw, Ind., is the center of the state's playground and is surrounded by thirty-seven beautiful lakes.

The many summer resorts, located on these lakes, among which is the one at Winona Lake, the former home of Billy Sunday, provide a constant source of toll business for the Kosciusko County Telephone Corporation, formerly the Commercial Telephone Company, one of the properties of the Interstate Telephone and Telegraph Company.

Year by year the toll business of that company has grown rapidly and in 1929 it grew to such a volume that the capacity of the Stromberg-Carlson toll board had been reached. The management of the company realized that the present-day public has been educated to demand not only good transmission on long distance calls but also a minimum of delay being connected with the parties which they call.

Realizing that the present board would efficiently not care for the increased toll business was certain to come in 1930, the management immediately contracted with the Stromberg-Carlson Telephone Mfg. Company for a four position toll switchboard.

The specifications for the new toll board stated that it must be capable of handling modern express toll service. This is known technically as Combined Line and Recording Service and is called C. L. R. In order to show the modern and most up-to-date service the Kosciusko County Telephone Corporation is giving its customers the older or "Hang-up" method of handling toll calls and the C. L. R. or "Non-Hang-up" method will be described briefly in the following paragraphs.

In the "Hang-up" method when a subscriber asked the toll operator or long distance, the call was trunked to a recording operator whose duty it was to enter on a toll ticket the calling subscriber's name and telephone number, the name of the party with whom he wished to talk and his telephone number in the town and city in which he was located. Having recorded this information, the recording operator would instruct the subscriber to "hang up and the operator will call you."

The toll ticket was then passed to another toll operator known as the line operator, who called the distant exchange and asked for the desired number and person, then called the calling party to the telephone, telling him "your party is ready."

Even if the subscriber only had to wait a few seconds it seemed to him a long time. With nothing to occupy his mind during the waiting time each second waited seemed a minute to him. The inside of every pay station booth is covered with a strange heiroglyphics made during this unoccupied time!

When the C. L. R. method is used the procedure is the same as the "hang-up" method up to the time the necessary information is recorded. At this point the operator tells the calling subscriber to "hold the wire" and proceeds to call the distant exchange to get the desired number and person.

The calling subscriber hears the operator working on the call and the waiting time seems and usually is much shorter. As the calling subscriber hears the call passed he also is able to correct any error that either he or the operator has made. Incidently means are provided whereby the operator can prevent the calling subscriber from becoming a hindrance rather than an aid until the connection is established.

The Stromberg-Carlson toll board has been in service in Warsaw nearly a year. It was cut into service just before the busy season of 1930 which begins the first of June and ends shortly after Labor Day. It has proven satisfactory in every respect and is handling the toll load on the new C. L. R. basis in a splendid manner.

---

cable laid directly into the ground will fit in with requirements in this country.

**Special Carrier Services**

Carrier currents may be used in chain broadcasting. This kind of transmission requires the utmost freedom from distortion, which, however, can easily be accomplished, at least to satisfy the requirements of program transmission, as the transmission takes place in one direction only, thus echo effects are evaded. Incidentally it may be mentioned that picture transmission may become a source of revenue for telephone companies; the requirements for accuracy and constancy in transmission would then be still more important.

Of far more importance has been and still is the telegraphing over carrier channels. Every telephone man is aware of the demand for, and the benefit derived from, the telegraph service over toll and long-distance lines. The revenue would be considerably increased by sending telegraph messages by means of carrier currents. It would require a lengthy introduction of the telegraph practice to go intelligently into this subject; we leave it to some opportunity in the future to take this up.

It may be of interest to know that carrier channels may be obtained also for submarine telegraphy and telephony. It was only in October, 1929, that telephone service was opened between two of the Canary Islands over a submarine cable about 40 nautical miles long. The cable is a single-core, non-loaded cable with a copper tape return; it has an ultimate capacity of six two-way carrier telephone channels and one direct-current telegraph circuit.

---

## FORMER TELEPHONE EXECUTIVE DIES

Herman J. Pettengill of St. Louis, Mo., retired telephone executive, died in St. Louis on January 12. Mr. Pettengill had been critically ill for some time. He was 79 years old.

Mr. Pettengill was one of this country's telephone pioneers, starting his career as a telegraph operator for the Western Union in 1870, during which time he was associated with Thomas Edison, and remaining in active service until 1927 when he retired as chairman of the board of the Southwestern Bell Company.

He was president of Southwestern Bell for seven years prior to his seven-year term as chairman of the board. Previously he served as president of seven other companies and vice-president of three.

During the first few years of his association with Southwestern Bell he made his home in Dallas, Texas, where he was active in business and civic affairs.

"Mr. Pettengill did much toward advancing the telephone business in Texas at that time," said Judge Nelson Phillips, general counsel in Texas for the Southwestern Bell Telephone Company, when informed of Mr. Pettengill's death. "The business was young at that time and so was the state."

★

# Proving the


## He gets the Best grain Prices . . . by Telephone

*A Bell System Advertisement*

INCREASED profits from his sales of grain are made by a farmer near Athens, Ill., who uses his telephone to keep in touch with his local farmer's co-operative. His additional returns from this source amount to a substantial figure. Among other transactions, he sold 300 bushels of wheat at a price within one cent of the highest figure that was quoted during threshing time—a price that was from 10c to 15c per bushel higher than that received by many other farmers in his neighborhood. By keeping posted on the right times to sell, he is always assured of receiving the maximum return on his crops.

* * *

The telephone is equally helpful in promoting profitable sales of livestock, fruit and vegetables through co-operative associations or local markets. It is always valuable in keeping up friendly contacts, making engagements and summoning help when sickness or accident occurs.

The modern farm home has a telephone that serves faithfully and well, rain or shine.

★

# the Value of the Telephone to the Farmer

THE FARM is a distinct and separate market for telephone service. The farmer's needs are peculiarly his own. And so the American Telephone and Telegraph Company talks to him in his own language, through publications edited in his interest. An advertisement from the current campaign is reproduced on the opposite page.

In general, these advertisements feature two types of telephone usefulness. They show the farmer how to get the best possible prices for his produce or livestock, and how to buy when the market is most favorable—*by telephone*. They remind him that the telephone keeps friendships alive and brings immediate help in case of accident or sudden sickness. Advertising of this character carries conviction because it is *true*. It is based entirely upon actual incidents, reported by farm residents all over the country and carefully recorded in our files.

It includes accurate figures and real addresses—everything but names. . . . It is helping to make farms everywhere more profitable and more livable. Likewise, it brings to rural readers an increased appreciation of telephone service—whether it be Bell or connecting company.

This advertising is appearing regularly in national farm magazines, in sectional and state farm papers and in farm organization papers.

*An Advertisement of the American Telephone and Telegraph Company*

# VACUUM TUBE THEORY AND PRACTICE

## AS APPLIED TO THE TELEPHONE CIRCUIT

### General

There are many uses around a telephone plant for a source of alternating current which has a frequency somewhere near 1,000 cycles. An alternating current of this frequency most nearly represents the average voice frequency hence is ideal for testing when it is desired to simulate the effect of voice currents passing through telephone circuits.

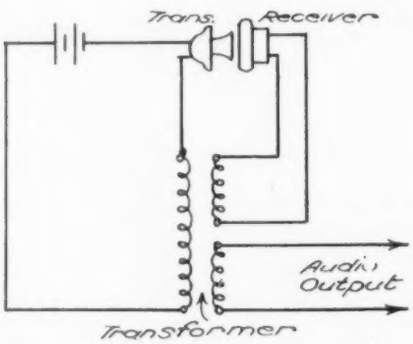



*Fig. 1. Howler type audio generator.*

This article discusses the uses of an audio oscillator and describes the construction of two types of vacuum tube oscillators which can be built by anyone at a very small cost.

### Uses of an Audio Oscillator in a Telephone Exchange

Some of the various uses of an audio oscillator around a telephone plant are as follows:

Useful in determining crosstalk conditions in apparatus and circuits. Tests are made by applying the tone on one circuit and listening on adjacent circuits for crosstalk effects.

Some form of tone is necessary in identifying cable conductors in connection with cable splicing operations.

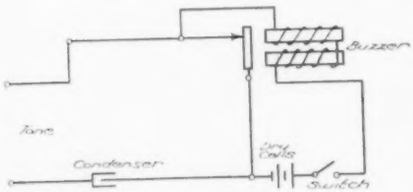



*Fig. 2. Buzzer type audio generator.*

Convenient in tracing out form wiring.

Can be used as the A.C. source in connection with a capacity bridge. (Note.—A simple practical capacity bridge which can be constructed for less than $2 will be described in an early issue of TELEPHONE ENGINEER.)

Useful in testing cord circuits also in locating trouble in key contacts in switchboards.

Can be used in making comparative transmission tests, such as was described in an article in the November, 1930, issue of TELEPHONE ENGINEER.

Useful in making tests on radio sets.

Useful in general continuity testing.

### Howler and Buzzer Type Audio Oscillators

There are several ways in which a tone approximating the average voice frequency can be obtained. One of the older methods of doing this was the "Howler" type generator, as shown in Figure 1. This tone generator operates on the principle that a small initial disturbance in the transmitter circuit will induce a current in the receiver circuit via the induction coil. This induced current in the receiver circuit is transformed into sound by the receiver diaphragm, and this sound is impinged directly on the transmitter which is closely coupled to the receiver. This causes another change in the transmitter circuit similar to the first and this change then goes through the same cycle as the first change. This cycle of events is repeated over and over, thus resulting in a source of alternating current at the terminals marked audio output.

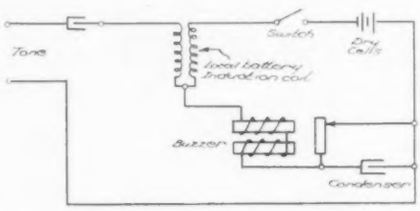



*Fig. 3. Improved type of buzzer tone.*

The frequency of such a source of alternating current will depend upon the receiver and transmitted diaphragm characteristics. The method has several disadvantages, the principal one being that the output can be heard directly from the receiver. It also has a poor wave form. The simplicity of the arrangement, however, warrants its use for some purposes.

The "buzzer" method of generating an alternating current tone consists in connecting a buzzer and battery as shown in Figure 2. When the buzzer armature is attracted to the pole pieces the contact is opened and the condenser is charged, the direct current path through the buzzer coils being opened, the armature falls back, closing the contact. This shorts the alternating current output line, causing the condenser to discharge. The resulting effect is the same is if an alternating current source was connected directly across the output terminals. The output frequency will be the same as the buzzer frequency.

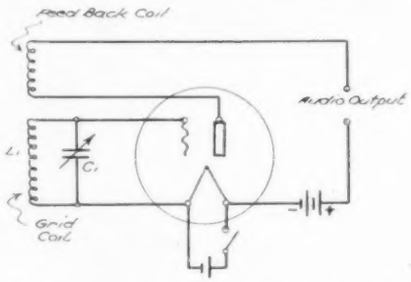



*Fig. 4. Elements of a vacuum tube audio oscillator.*

This method of generating a source of alternating current tone is very popular in connection with cable splicing but has the same objection as the "howler" method as to the tone being directly audible. Figure 3 shows the circuit of an improved type of buzzer tone generator.

### Vacuum Tube Oscillators

The vacuum tube makes an ideal oscillator, for unlike the howler or buzzer type oscillators previously described, no sound can be heard directly from the oscillator equipment.

The operation of a vacuum tube oscillator may be explained by reference to Figure 4, which shows a simple type of tube oscillator.

It will be noted that the output or plate circuit is inductively coupled to the input or grid circuit. When the battery circuit is closed, the surge of current through the plate coil will induce a voltage across the grid coil which will be impressed on the grid. The change in grid potential will cause a corresponding

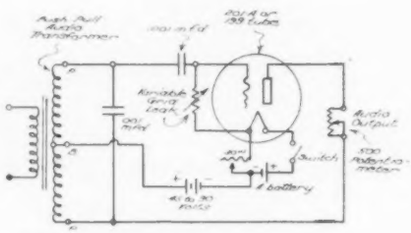



*Fig. 5. One-tube audio oscillator.*

# The Toll Board's Silent Partner

LITTLE fuss is ever made over the Calculagraph. It is such a small, compact, trusted and tried instrument that it's taken pretty much for granted by 99% of the world's telephone companies. But do not overlook its importance. Without the Calculagraph on the toll board, records of toll charges would indeed be in a sorry plight.

The Calculagraph stamps on the toll ticket the beginning of each call together with the time elapsing during each call, down to the quarter of a minute, for any number of calls—producing a permanent and accurate record of each.

Prices and Information on Request.

THE CALCULAGRAPH COMPANY
50 Church Street Dept. 22 New York City

CALCULAGRAPH
THE ELAPSED TIME RECORDER

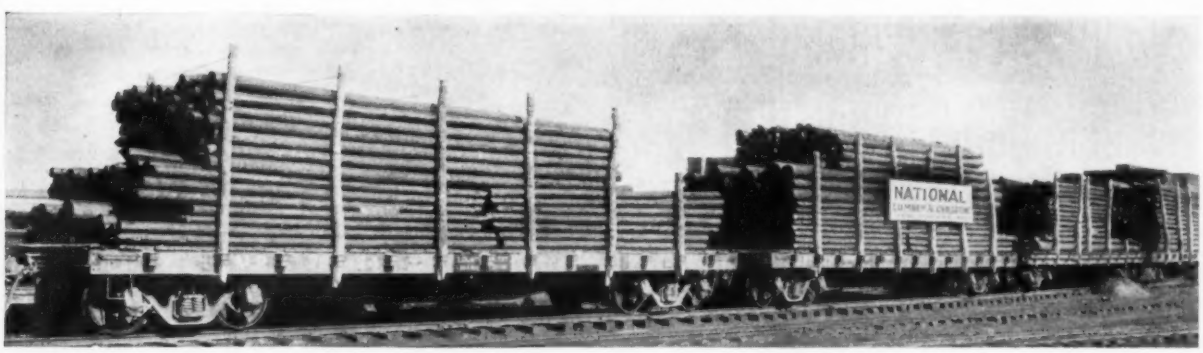
# Do You Buy *Batteries* or *Hours of Service?*

COST per *service hour*—not cost per *battery*—is the only way to gauge battery prices. A telephone cell that gives only six or seven months of service is high-priced, no matter what you pay for it. Ray-O-Vac Telephone Batteries cost less because they deliver more hours of service than other batteries. Tests conducted in accordance with U. S. Government standards, as well as records of users, prove that Ray-O-Vacs deliver many hours more actual service than most other makes. And over a period of time, there's a considerable saving in service costs alone. It will pay you to standardize on Ray-O-Vacs. They *last* longer.

**FRENCH BATTERY COMPANY**
**Madison, Wisconsin**
*General Sales Offices:*
*20 North Wacker Drive, Chicago, Illinois*
Makers also of Flashlight Batteries, Rotomatic and Standard Flashlights and Electric Lanterns

RAY-O-VAC

The real Economy, Strength and Long Life of National Lumber & Creosoting Company poles are reflected in their unusually low unit-cost-per-year. Southern Yellow Pine for strength — Pressure Creosoted for Permanence. Ample stocks assure quick shipments.




# National Lumber & Creosoting Company

GENERAL OFFICES: TEXARKANA, ARK.-TEX.

SALES OFFICES
Texarkana, Ark. Houston, Tex.
Kansas City, Missouri
St. Louis, Mo. Denver, Colo. Superior, Wis.

TREATING PLANTS
Texarkana, Tex. Houston, Tex. Alexandria, La.
Finney (P. O. Col. Park, O) Kansas City, Mo.
Salida, Colo. Denver, Colo. Superior, Wis.

but amplified change in the plate circuit. This amplified version of the original current surge will pass through the plate coil, inducing a larger voltage across the grid. This cycle is repeated over and over and with each succeeding cycle the amplitude of the oscillations impressed on the grid is increased until the limit of the tube is reached, at which point the tube will continue to oscillate at a constant frequency and amplitude. The peak value to which the oscillations will build up will depend on the tube constants and circuit characteristics. The frequency of the oscillations will depend on the values of inductance and capacity present in the grid and plate circuits.

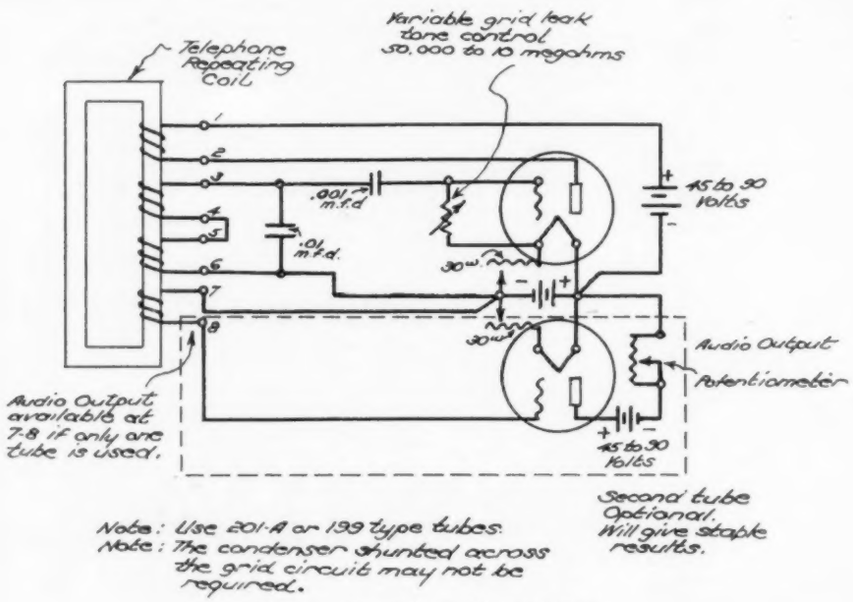



*Fig. 6. Two-tube audio oscillator.*

The conditions upon which oscillations depend in a vacuum tube oscillator are as follows: The output (plate) circuit must be properly coupled to the input (grid) circuit, the tube must amplify, and inductance and capacity must be present in the circuit.

### Frequency of Oscillations

The frequency of the generated alternating current of a vacuum tube oscillator will depend upon the values of capacity and inductance across the tuned circuit. By regulating these values any desired frequency can be obtained. Regular radio type receiving tubes can be made to oscillate on frequencies as high as several million and as low as a few cycles. An explanation of how inductance and capacity regulates the frequency in an oscillating circuit may be of interest to those not familiar with this phenomena. Referring to Figure 4, at the instant the filament switch is closed a current surge in the plate circuit will cause the condenser to charge and discharge in the closed circuit formed by the condenser $C_1$ and inductance $L_1$. The frequency of these surges or oscillations will depend on the inductance and capacity of $C_1$ and $L_1$, and can be determined mathematically by the relation:

$$\text{Frequency} = \frac{.1592}{\sqrt{LC}}$$

when L = inductance in henries
C = capacity in farads.

For example, a 2 m.f. condenser in series with an inductance of 1.27 henries would give an oscillatory circuit of approximately 1,000 cycles. As stated in the previous paragraph, these initial oscillations in the plate circuit are by induction impressed on the grid circuit which in turn sets up a corresponding frequency change but of greater amplitude in the plate circuit.

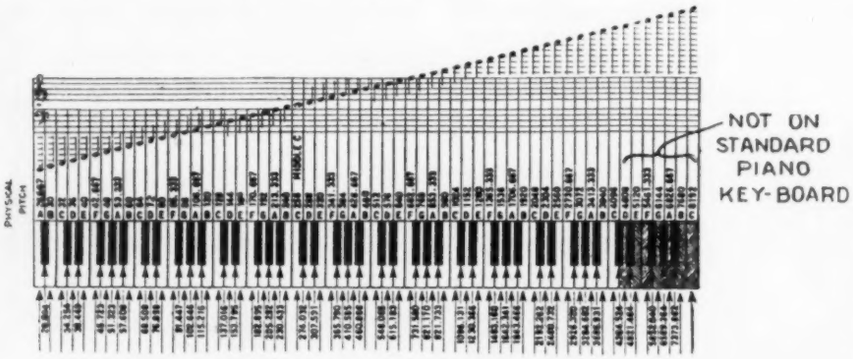



*Fig. 7. Frequencies corresponding to piano notes.*

It is of course necessary that the feed-back circuit be so "poled" as to cause the reinforcing or amplified oscillations to be in phase with the initial or starting oscillations, otherwise, the oscillations due to the initial surge will immediately die out.

### Construction Details

Figures 5 and 6 show the schematic circuits of a one tube and a two tube audio oscillator.

The two tube oscillator offers a somewhat more stable output than the single tube set, although either circuit will be found very satisfactory.

In the two tube set the oscillator operates in the same manner as already explained; however, the output of the oscillator tube is connected to the grid of the amplifier tube, thus the output of the amplifier tube will have the same frequency as that present in the grid circuit of the oscillator tube circuit. The external load not being connected directly to the oscillator will reduce the tendency for the frequency to change with change in load.

The transformer shown may be either a push pull transformer such as is used in radio sets, or a telephone repeating coil connected as shown. The condensers may be regular telephone or radio condensers. The grid leak should be of the variable type.

Tubes should preferably be of the UX-199 type, as this permits mounting the set in a small portable box containing both filament and plate batteries.

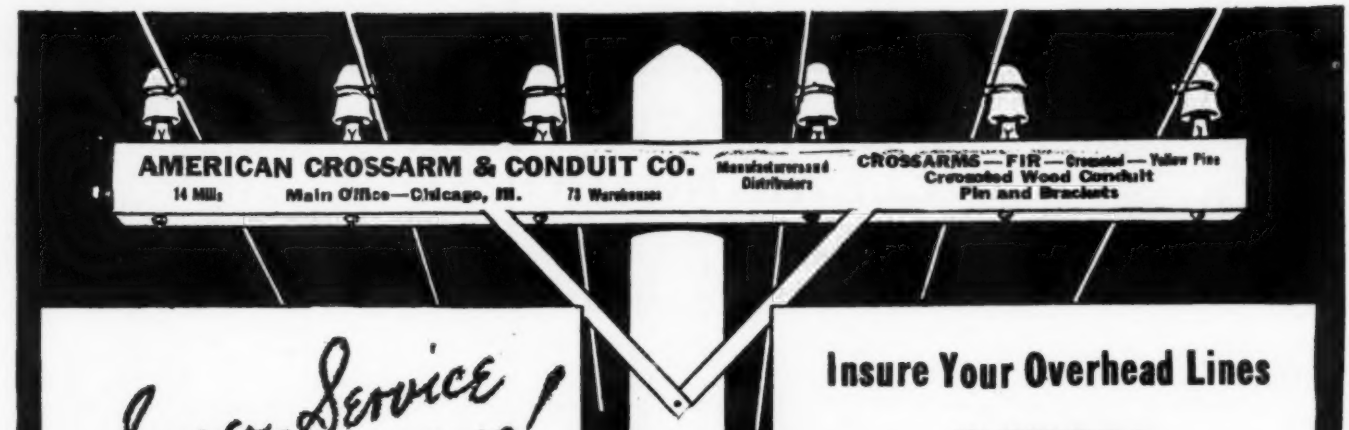
The variable grid leak on the oscillator tube permits a wide range of tone control. This method of controlling the pitch of the audio output is radically different from the control of the output frequency by means of varying the inductance or capacity of the tuned circuit. However, the resulting wave form using the grid leak method of control is satisfactory for the purposes for which the oscillator is ordinarily used.

By increasing the grid leak resistance to a high value the tone output can be interrupted at any desired periodic rate. This permits using the oscillator as a tone source for locating cable trouble by the exploring coil method.

In the construction of the oscillator shown in Figure 6 it is important that the plate feed-back coil be properly poled, otherwise the grid and plate circuit voltages will be out of phase and oscillations cannot be set up.

The small .01 grid circuit condenser shown in Figure 6 may not be required,

(*Continued on page* 54)




*Super-Service on rush orders!*

If you are in a hurry your order can be loaded and on the way the same day we receive it. Quality poles since 1882 assures you of guaranteed stock and satisfactory dealings. Let us quote you prices.

Northern and Western Cedar
With or without butt treatment

NAUGLE POLE & TIE COMPANY
59 East Madison Street, Chicago

Branches: New York, Columbus, Kansas City, Spokane, Los Angeles, Boston, Madison.

Main Yards and Butt-treatment Plants: Minneapolis, Pinconning, Michigan, Spokane, Sand Point, Idaho, Seattle, Arrowhead, B. C.

**Naugle Poles**

**Insure Your Overhead Lines**

BY SPECIFYING

**MacGillis**

**NORTHERN or WESTERN**

**CEDAR POLES**

**PLAIN or BUTT-TREATED**

**FROM**

120 E. Wisconsin Avenue

**The MacGillis & Gibbs Co.**

MILWAUKEE - WISCONSIN

Carney

Producers of

"CARNEYPOLES"

of

WESTERN RED CEDAR

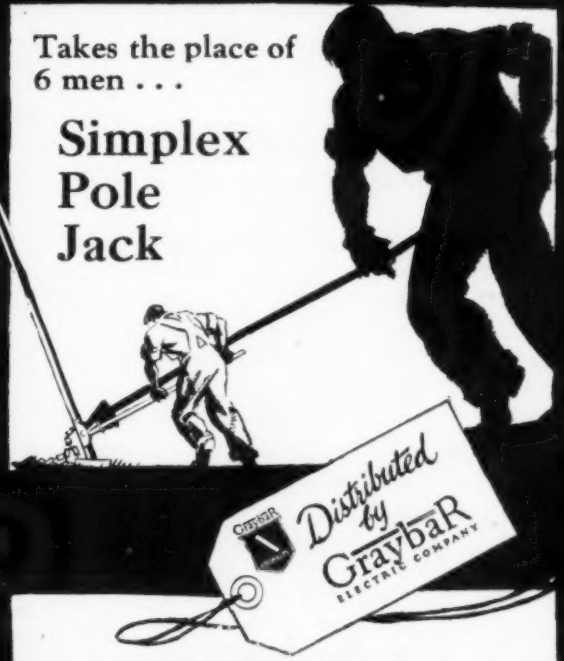
Plain or Treated

B. J. CARNEY & CO.

100 No. Seventh St. Minneapolis, Minn.

Takes the place of 6 men . . .

Simplex Pole Jack




Templeton, Kenly & Co., Ltd.
*Sole Manufacturers*
Established 1899 Chicago, Ill., U. S. A.

Foreign Distributors:
International Standard Electric Corporation
Northern Electric Company, Ltd.

**Cedar Poles**

Northern White Western Red

Plain or Treated Butts

*Prompt Shipment from Minneapolis Yard.*

**T. M. Partridge Lumber Co.**

Minneapolis, Minn.

# THE TECHNICAL CLEARING HOUSE

B. C. BURDEN, Editor

### Location of Cable Faults

Q.—Can moisture trouble be located in telephone cable using the Wheatstone Bridge?

A.—Yes, the Wheatstone Bridge offers an ideal method for locating moisture faults caused by sheath breaks. It is essential that a good wire free from grounds or crosses be available in the cable which is in trouble. Either the Varley or Murray Loop methods are satisfactory. Considerable information as to the bridges can be obtained by writing the Leeds & Northrup Company, Philadelphia, Pa. Briefly, the method of locating trouble in cable by bridge methods is as follows: The good conductor and one of the bad conductors having a leak to ground are strapped together at an end terminal and the bridge connected as shown in Figure 1.

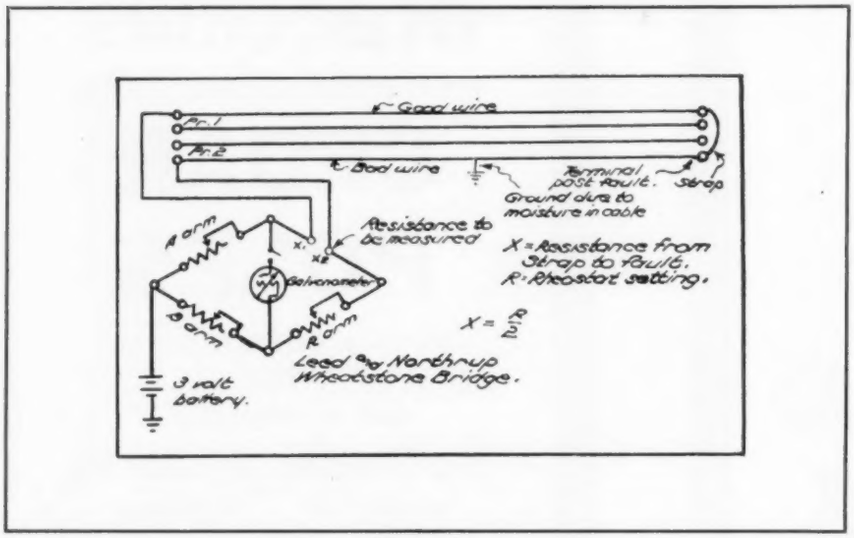



*Figure* 1.

With equal ratio arms and the bridge balanced the resistance of the bad wire from the strap at the end terminal to the fault is found by dividing the rheostat setting in ohms by 2. The actual distance in feet is obtained by multiplying this value by the number of feet per ohm for the particular cable involved. With ordinary care taken in making measurements the computed location will fall within a few feet of the actual. The sheath break can then be easily located by examining the cable sheath each way from the computed location.

### Inductive Interference on Grounded Line

Q.—We have a situation where three of our grounded lines are paralleled by a high voltage power line for one mile. We plan on rebuilding our lead on a different route, sometime in the next year or so. Is there any way in which we can reduce the noise to a satisfactory value without making our lines metallic?

A.—It is possible as a temporary measure to reduce the noise by stringing a single No. 12 copper wire through the parallel and connecting a repeating coil to each grounded line and the common return copper wire as shown in the following figure. Such an arrangement while effective from the standpoint of noise reduction should only be considered as a temporary practice, as considerable crosstalk will result with the method suggested unless great care is taken to keep the resistance of the common return quite low, and the real solution of the inductive problem is to make rural lines metallic throughout. See Figure 2.

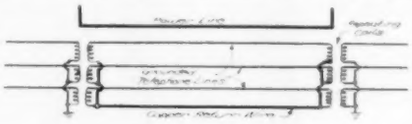


*Figure* 2.

### Radio Interference from Ringing Machines

Q.—We have a ringing machine of the type that converts 110 volts 60 cycle A. C. current to 90 volt, 20 cycle, current. This machine has vibrating relays which rectify the current and then pulse it through a transformer by means of a tuned reed so as to give a 20 cycle current. It is impossible to use a radio in the same building with the ringing machine and considerable interference is caused to nearby receiving sets. How can this noise be suppressed?

A.—Radio frequency noise due to the type ringing machine mentioned is very difficult to eliminate unless special precautions are taken. The best results will be obtained by connecting well designed radio frequency choke coils in the 110 volt input leads, also in the output leads, together with shunting condensers as shown in Figure 3.

This arrangement is usually satisfactory to reduce noise caused to radio sets not located in the same building, nor fed from the same transformer as the ringing converter. It will usually be necessary to enclose the ringer and choke coils in a sheet iron case which should be grounded if satisfactory reception is to be obtained in the same building.

### Conductivity of Yellow Pine Poles

Q.—Is it possible to get a considerable ground leak due to an open wire touching the surface of a creosoted or ZMA treated yellow pine pole?

A.—This will depend on the seasoning of the pole. Conductivity of yellow pine timber varies greatly, depending upon the moisture content of the wood.

### Selective Ringing on Farm Lines

Q.—Can full selective ringing be given on multi-party farm lines?

A.—Yes, this is feasible, and such systems are being used by various companies. The plan consists in using five frequency harmonic ringing with five parties on the tip and five parties on the ring side of the line, thus giving full selection of any of the ten parties on a line.

### Silent Signalling for Rural Lines

Q.—What is meant by the term "silent signalling" as applied to rural multi-party lines?

A.—This expression refers to the arrangement whereby the subscriber pushes a button to signal the operator so that none of the other subscribers on the line are aware that a call is being made. With such a system subscribers can signal each

## We Carry Complete Stocks of

TELEPHONES, TELEPHONE APPARATUS
• CONSTRUCTION MATERIALS
AND SUPPLIES

OUR unusual facilities as manufacturers and distributors of telephones, telephone apparatus and manual and automatic switchboard equipment enable us to render unexcelled service in Western Canada.

## Independent Sales and Engineering Company, Limited

VANCOUVER, B. C.

Representatives in Western Canada for

AMERICAN ELECTRIC CO., INC., Chicago AUTOMATIC ELECTRIC INC., Chicago
AUTOMATIC TELEPHONE MANUFACTURING CO., LTD., Liverpool
THE AUTOMATIC ELECTRIC COMPANY, LIMITED, Chicago

# TELEPHONE WIRES and CABLES • • •

Electrolytic Copper Rods
Bare and Insulated Copper Wires
Switchboard Cables
Rubber Insulated Wires
Magnet Wire
Flexible Cords
Enamelled Wire
Power Cables

## Eugene F. Phillips Electrical Works Limited

(Established 1889)

MONTREAL, CANADA

Factories—Montreal and Brockville

other on the line without operating the C. O. drop by not depressing the button when ringing. The only disadvantage of this arrangement is the fact that the drop is connected from one side of the line to ground which may cause considerable inductive interference if the rural line is involved in a power parallel. See Figure 4.

**Cleaning Relay Contacts**

Q.—What is an approved method of cleaning dirty relay or key contacts?

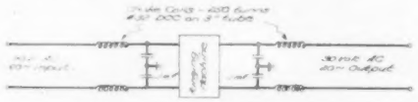


*Figure 3.*

A.—This can best be accomplished by holding the contacts open and flushing with a drop of carbon tetrachloride picked up on the end of a toothpick. The flat side of the toothpick should be inserted between the contacts and pulled back and forth several times to loosen any dirt or grease that may be present. The contact points should again be flushed

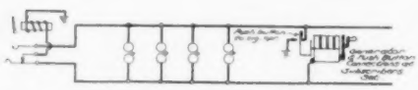


*Figure 4.*

with a drop of carbon tetrachloride. If the contacts are rough they should be cleaned and then burnished with a *regular burnishing tool.* Contact files of the type used in automotive work should never be used on telephone contacts.

**Cable Fault Location**

Q.—In locating wet cable trouble by the bridge method is it necessary that the good wire be in the same cable as the bad wire?

A.—No, this is not necessary, except where the simple Varley formula $X_1 = \frac{R}{2}$ is used.

Where: $X_1$ = Resistance from strap to fault
$R$ = Rheostat setting in ohms.

If the formula $X_2 = \frac{r - AR}{A + 1}$

Where: $X_2$ = Resistance from bridge to fault
$r$ = Resistance of loop
$A$ = Multiplier dial reading
$R$ = Rheostat reading

is used the good wire may be any resistance. When all the conductors in a cable are bad, it is often necessary to pick up a good wire from some nearby cable by means of drop wire strung out on the ground.

Q.—How may crosstalk between a grounded and a metallic line on the same crossarm be avoided?

A.—Transpose the metallic line at the one-fourth and three-fourths points in each mile which should effectively prevent crosstalk between the two lines.

Q.—What simple test can be applied to a magneto subset to determine the receiving efficiency of the set?

A.—The receiving efficiency of a set depends primarily on the condition of the receiver. The air gap spacing between pole pieces and diaphragm, the strength of the permanent magnet, and the mechanical condition of the diaphragm should be examined. A new receiver can be carried and provided with clips so that it can be quickly bridged across the receiver terminals in the subset, and by listening to line noise first over the standard and then over the regular receiver, its receiving efficiency can be determined.

# Minnesota Telephone Men Convene

## Importance of Selling Service Is Emphasized; S. A. Rusk Succeeds Irving Todd as President.

Emphasizing his belief that the possibilities of telephone companies as service agencies are unlimited, President Irving Todd of the Minnesota Telephone Association addressed delegates to the twenty-second annual convention of Minnesota telephone men held at the Lowry Hotel, St. Paul, January 27, 28 and 29.

He praised members of the association for the coordination of their efforts because of which he said the association is laying the foundations of a strong service organization.

Citing the progress of television and international communications which made 1930 such a memorable year for the telephone industry, President Todd told of the contributions made in Minnesota toward the world's telephone advancement.

He mentioned the commencement of an imposing new office building in Minneapolis by the Northwestern Bell Telephone Company; acquisition of the St. Paul property of the Tri-State Telephone & Telegraph Company by the Northwestern Bell company (authorization of the latter transaction still awaits decision of the regulatory body); consolidations eliminating many of the smaller and less successful companies; construction of numerous new exchange buildings; the introduction of the repeater station and the extension of the underground cable system to facilitate long distance communication with the east; and the successful rate cases which have been presented to the Minnesota Railroad and Warehouse commission.

Ways and means of increasing revenue through sales campaigns proved to be an important topic of discussion throughout the convention. Members were assured by President Todd that as the result of the obvious interest in this subject, the association directors undoubtedly would take steps to assist member companies to conduct successful sales campaigns.

This subject was treated by R. A. Lumpkin of Mattoon, Ill., president of the Illinois Southeastern Telephone Company and president of the Illinois Telephone Association who was a guest speaker at the convention. In enumerating various by-products which could be used to enlarge the market of the company he mentioned secretarial service, the use of the company's addressograph for providing lists for circularizing purposes and the possibility of toll service increase.

The need of aggressive sales effort sounded the keynote of an address given by J. P. Mason, general commercial manager, Northwestern Bell Telephone Company, St. Paul.

"Proper selling makes the service more valuable for everyone by extending its usefulness through the increased number of persons who can be reached over the 'voice highways' as more telephones are added," he said. "Selling also helps to adapt the amount and type of equipment to each subscriber's needs, so that his service will be not only reliable and adequate, but the most economical, convenient and comfortable for him to use.

"There was a time in the development of the telephone art when it was generally believed that there was no need for an aggressive sales effort. However, with changing economic influences, we became aware of the fact that we had a big job to do in selling the telephone industry."

Mr. Mason says one of the soundest and most productive planks in telephone sales activity is all-employe participation.

During the convention several suggestions were made as to unexplored fields in selling telephone service. Among these were rural schools, which generally have been overlooked as telephone prospects; and garages and filling stations which could be fitted with telephone booths as logically as drug stores, since they probably are visited by as many persons during the day.

Other guest speakers at the convention included: Governor Floyd B. Olson of Minnesota; S. T. Gullicksen, vice-president and general manager of the Churchill Cabinet Company, Chicago; F. B. MacKinnon, president of the United States Independent Telephone Association, who spoke on "Maintaining the Prestige of the Telephone Company;" Mark T. Caster, general plant superin-

(*Continued on page* 54)

# Transmitters

**repaired**
**recharged**
**refinished** and
**packed in individual cartons**
**just like new**

**In 100 Lots**

# All for 37c Each

SUTTLE TRANSMITTER SERVICE renews your old transmitters to their original efficiency and appearance, so that they are just like new. We handle thousands of transmitters each month and can afford to keep specialists on this work.

Try it and see for yourself. Just pack your old transmitters in a box and ship them to us. Send itemized list and instructions in separate letter. Specify Operation A-1 or A-2 as described below—whichever best suits your needs.

**Operation A-1—Complete Repair and Renewal**

(When transmitters are sent in without backs)
Includes renickeling or re-enameling transmitter fronts, painting diaphragms, replacing granular carbons, new rubber gaskets, new terminal wire, and adjusting and testing for voltage.

Be sure to state whether transmitters are for magneto or common battery telephones.

| | Without Name Plate on Front | With Name Plate on Front |
|---|---|---|
| One only | 62c | 64c |
| 2 to 10, each | 52c | 54c |
| 11 to 50, each | 47c | 49c |
| 51 to 100, each | 42c | 44c |
| 101 to 500, each | 37c | 39c |
| 500 to 1,000, each | 36c | 38c |

An extra charge of 20c will be made for installing new electrodes when this is necessary.

**Operation A-2—Recharge Only**

(When transmitters are sent in without backs)
Includes replacing granular carbons, new rubber gaskets, new terminal wire, and adjusting and testing for voltage.

Be sure to state whether transmitters are for magneto or common battery telephones.

| | | | |
|---|---|---|---|
| One only | 50c. | 51 to 100, each | 30c |
| 2 to 10, each | 40c | 101 to 500, each | 25c |
| 11 to 50, each | 35c | 501 to 1000, each | 24c |

## Suttle Equipment Co.

**Lawrenceville, Illinois**

# How to tie up service . . . *wholesale!*

. . . It doesn't take much defective telephone cable to tie up a whole system . . . silence the busiest lines . . . win the wholesale ill-will of subscribers . . . To maintain "unbroken service," the watchword of the telephone industry, it pays to use the finest cable obtainable. It more than pays to install Western Electric Lead Covered Cable . . . not the cheapest cable, but the most economical in the long run . . . Why is Western Electric better? The answer is easy . . . Experience since the earliest days . . . largest and best manufacturing facilities . . . selected quality materials . . . careful testing and re-testing . . . and all the tradition for quality implied by the name, Western Electric.

GraybaR

OFFICES IN 76 PRINCIPAL CITIES. EXECUTIVE OFFICES: GRAYBAR BLDG., NEW YORK, N. Y.

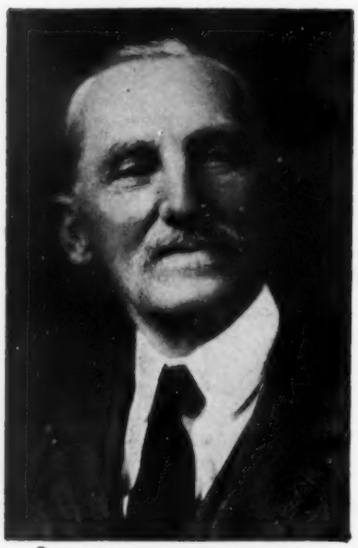
# Cape Girardeau Has New Exchange Building

**Story of the Growth of the Southwest Missouri Telephone Company Climaxed by the Opening of This Imposing New Structure in Cape Girardeau, Which Is Completely Modern Throughout Including Kellogg Full Feature Central Office Equipment as Told.**

By E. R. SEARS
Sales Representative, Kellogg Switchboard & Supply Co.

The Southwest Missouri Telephone company recently celebrated a milestone which its friends and patrons will remember for some years to come, with the completion of the largest construction project in their colorful history, when they officially opened the beautiful new building and placed in service the new full feature switchboard which it houses.

Thirty-two years ago four public spirited men in a little river town in Missouri organized a telephone exchange, and called it the Cape Girardeau Bell Telephone Company. These pioneers, M. A. Dennison, A. R. Ponder, L. J. Albert and J. F. Brooks, set up their switchboard in the second story of the bank building and began serving their neighbors.



*John Tlapek, president of the Southeast Missouri Telo. Co., Cape Girardeau, Mo., has been identified with the company for 28 years.*

By 1904 their business had grown to 480 subscribers, and the infant industry was having visions of expansion. The Mississippi River with its tributaries was the principal transportation route for the awakening Middle West, and Cape Girardeau was an important town. Further up the river was St. Genevieve, also a good river port, whose citizens had the same interests as those of "the Cape." A closer relationship between the two towns seemed advisable, and a merger was consummated with the Cape Girardeau company, serving and supplying toll connection to both communities.

At this time Messrs. Dennison and Ponder relinquished their places on the stockholders register, and the names of Henry L. Rozier, John Tlapek and L. H. Parker appeared. Mr. Rozier was the first president of the new organization and served until succeeded in 1927 by Mr. Tlapek, then first vice-president and the executive head of the company today.

Under this management, the company grew and prospered. New exchanges were built or purchased, and the surrounding public was well served. One of the most valuable assets acquired during this period was a young railroad clerk, Charles W. Boutin, who took a clerical position in 1906 under Mr. Ponder, then secretary. In 1913 Mr. Boutin was officially listed as secretary, and a short time later the duties of treasurer were placed on his shoulders. Being successful with these responsibilities, he accepted the duties of general manager in 1927.

*Charles W. Boutin, vice-president, treasurer and general manager of the Southeast Missouri Telo. Co., Cape Girardeau, Mo., has been connected with the company for 24 years.*

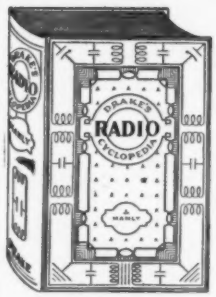
In 1929 negotiations were completed with the Southwestern Bell Telephone Company whereby that company turned over its property in twenty-three towns to the Cape Girardeau company, which reorganized under the name of the Southeast Missouri Telephone Company. Mr. Tlapek is president of the present organization, and Mr. Boutin's ability is again president, treasurer, and general manager.

Throughout these years of careful and foresighted management a telephone empire has been built with Cape Girardeau as its capital. A $3,000,000.00 industry, serving 20,000 stations in thirty-five closely surrounding towns, is the reward for their labors. A toll system connects these exchanges with 2,300 miles of line, and 275 employees transact the company's business.

*A. W. Berry, general plant superintendent of the Southeast Missouri Telo Co., Cape Girardeau, Mo., supervised the laying out of all details of the new equipment and building*

While the company has been growing, the territory has changed very materially from the sparsely settled country that it was in 1898. Cape Girardeau today is an industrial center of 16,250 people and consequently had outgrown its telephone system. With its usual foresight and thoroughness, the company in 1928 began to study the requirements in their principal exchange. The thoroughness of their work and the ability of those in charge is best testified by the magnificent new structure which has just been put in service in Cape Girardeau.

The building stands upon a foundation of square cut Bedford stone which is




**DRAKE'S RADIO CYCLOPEDIA**
By HAROLD P. MANLY

A Complete and Non-technical Reference Work, covering nearly 1700 subjects arranged alphabetically, including instructions for building, operating and testing receivers, power units and radiophone equipment. Arranged for use by set builders and designers, service and repair men, dealers and salesmen, experimenters and students, set owners and operators. 871 Pages. Size 6x9". 985 Illustrations. Circuit Diagrams, Constructional Layouts and Graphic Curves. All made especially for this book. Bound in Art Buckram. Stamped in Two Colors. Price ..... $6.00

**Send Order Direct to**

**TELEPHONE ENGINEER**
**192 N. Clark St., Chicago, Ill.**

**IS YOUR LIBRARY COMPLETE?**

Our complete catalog of Technical Books is yours for the asking. Learn more—earn more. Technical men are given preference. Address

TELEPHONE ENGINEER,
192 N. Clark St. Chicago, Ill.

# UNDERGROUND TELEPHONE CABLE

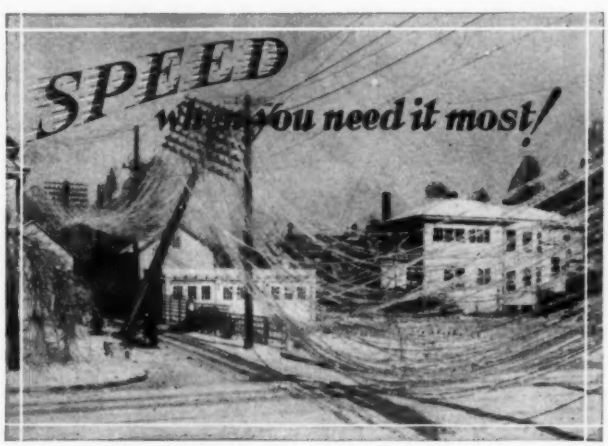
is surely worthy of the very best treatment. So, in pulling it through the duct, we suggest the use of

# MINERALLAC PULLING COMPOUND

It saves the lead sheath, shortens the pulling time and cuts down expense of installation.

*Ask for the folder on Minerallac No. 150*

**MINERALLAC ELECTRIC COMPANY**
**25 North Peoria Street**
**CHICAGO**




***Crapo* Galvanized Products**

***Telephone and Telegraph Wire***

***Steel Strand***

A sleet storm.... Miles of line down.... Wire stocks inadequate .... Rush shipments imperative.... Then look to Jobbers of *Crapo* Galvanized Wire and Strand.... You can depend upon them in every emergency....and they, in turn, can depend upon us....for they know from experience that RUSH orders received by us in the morning are shipped before night....

***Indiana Steel and Wire Company***
***Muncie, Indiana. U.S.A.***

# TELERING

**The Ringing Machine Designed to Meet ANY Load Requirement**

**FULLY GUARANTEED**

**LET US PROVE IT TO YOU!**

**NO RADIO INTERFERENCE**

**Operated by Commercial Alternating Current**

**Price $44.00 F. O. B. Elyria**
**It pays for itself.**

**Sold by Leading Telephone Distributors.**

**TELKOR, INC., ELYRIA, OHIO**
**(Write for booklet)**

enhanced by well kept lawns on all sides. Above the first floor line the walls are of golden yellow brick in two shades, broken by large triple windows. The building presents a very massive appearance, but the sharp angles have been skillfully softened by a trimming of carved terra cotta of a somewhat lighter shade than the brick. The same design in terra cotta has been continued throughout in the pilasters between windows and in the doorways, so that the general tone of the building suggests a public library, or other such institution, rather than the home of a business enterprise. The bronze doors in the massive main entrance open directly into the front lobby where the interior is done in Italian Renaissance style. Surrounding the lobby are the private offices of the executives and the public business and commercial offices. This portion of the building is wainscoted in panel walnut, with ceilings and walls finished in soft pastel colors.

The employees' entrance is at the side of the building, and opens on a small lobby and stairway to the second floor. To the rear of this lobby the terminal room is located, housing the main frame, relay rack, power equipment, long lines apparatus, and Wire Chief's desk.

The basement extends the full width and length of the building, and is so arranged as to provide ample air and daylight to the various departments located in that part of the building. Aside from the usual battery room and cable vault, repair shop, and storage room, this large space has been used for many conveniences and some novelties. Locker rooms are provided in this section for all the men, with the additional convenience of a large and comfortably furnished club room. The last word in heating appliances, consisting of an automatically set and automatically regulated boiler, makes possible a white tile boiler room through the elimination of dust and smoke.

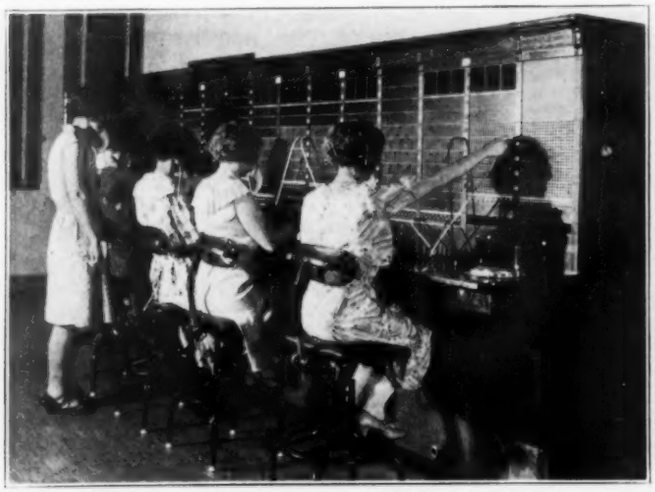
The second floor is divided between the traffic forces and the general advertising plant and accounting departments.

Mr. A. Jackson Harty is advertising manager in which capacity he also edits the "Southeast Missouri Telephone News" and publishes the company's ten directories. J. C. Woody, as general commercial superintendent, supervises all collections, new business and public relations of the entire system.

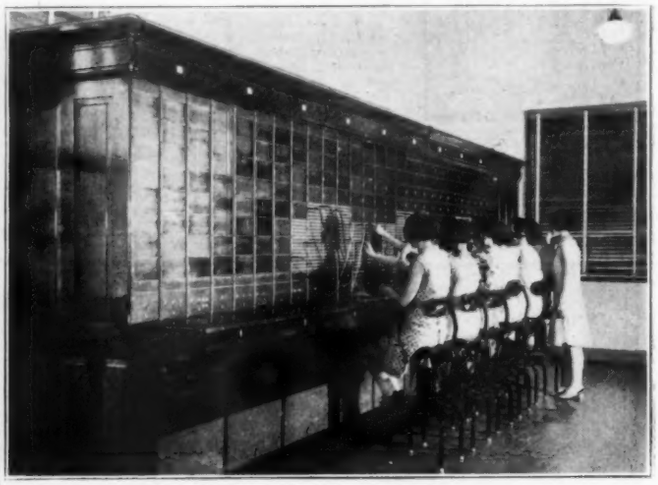
The entire rear of the building is occupied by switchboard equipment, opertaors' rest rooms and locker rooms, completely equipped operators' kitchen and dining room.

All of the various departments of the Cape Girardeau exchange are connected to a Kellogg P. B. X. switchboard. This board is equipped with ten trunk lines to the main exchange and local lines to a telephone on every desk in the building.

Every fitting and accessory of the building speaks of permanence and efficiency. The present two story structure is designed to take three additional stories as the requirements may demand. Every convenience is given the employees in their service to the public.

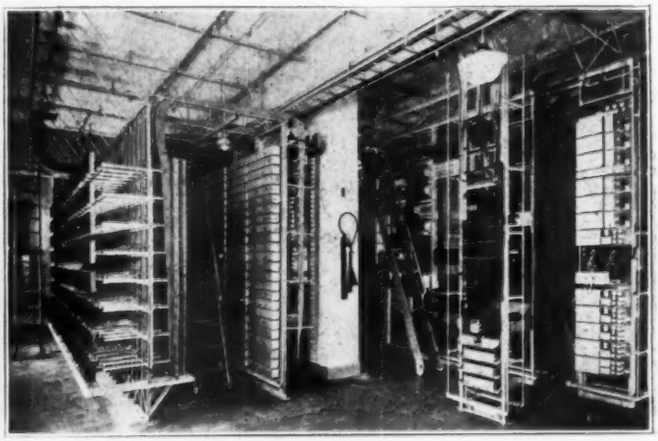


*Front view of new Kellogg four-position toll switchboard with operators at their positions, which has been installed by the Southeast Missouri Telo. Co., Cape Girardeau, Mo.*



*New Kellogg nine position local switchboard in Cape Girardeau Exchange*

*New general office building of the Southeast Missouri Telo. Co., Cape Girardeau, Mo., which, together with new Kellogg central office equipment, represents a total investment of $250,000.*



*View of terminal room at Cape Girardeau exchange of the Southeast Missouri Telo. Co., showing the main frame, relay rack and long lines equipment which serve the new Kellogg switchboard.*

## For Underground Cable Construction Tools

use the "Cope"

*Catalogue on request.*

Cable Rack
Bond Plate
Winch
Guard Rail
Conduit Rod
Bond Wire
Capstan
Cable Reel Jacks
etc., etc.

**T. J. COPE, Inc.**
Manufacturers of
Complete Equipment for Cable Installation
19 So. LaSalle Street, Chicago, Ill.
6122 Vine Street, Philadelphia, Pa.

## RUNZEL-LENZ ELEC. MFG. CO.
ESTABLISHED 1904 CHICAGO

Specializing in Manufacture of

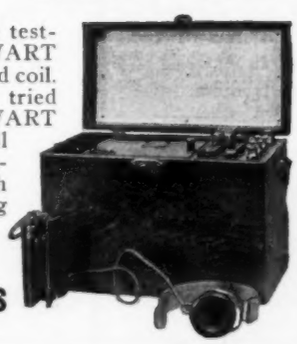
# CORDS

## FOR ALL CLASSES OF TELEPHONE WORK

SIERRE EQUIPMENT CORPORATION
Los Angeles—San Francisco—Seattle—Pacific Coast Distributors

## "STEWART" Cable Tester

Trade in your old cable tester, any make, on a STEWART Cable Tester with balanced coil. One user says: "I have tried them all, and the STEWART is the only one that will always locate water trouble." Price, complete with receiver and exploring coil, $57.00.



Sent on Trial.

STEWART BROTHERS
OTTAWA, ILLINOIS

Note Protection at Corners

## Blake Insulated Staples
Trade Mark

Unequalled for telephone and bell wiring. The fiber insulation prevents troublesome short circuits and grounds. 4 sizes. Pat. Nov., 1900. Write for samples.

Blake Signal & Mfg. Co.
BOSTON, MASS.

# EFFICIENCY

Here are two lights universally accepted by "trouble shooters" as superior for every requirement.

The Industrialite makes and breaks contact conveniently through a twist of the top cap. An emergency bulb is kept in a tiny clip within the head assembly.

The Lantern needs no introduction to telephone men. It brilliantly illuminates a wide area and may be used at any angle.

BOND ELECTRIC CORPORATION
Jersey City, N. J.
CHICAGO SAN FRANCISCO

With such a building nothing but the best in equipment could be tolerated. From every standpoint, the new Kellogg switchboards are the latest word in service, efficiency and economy. The design and finish of the cabinets blend perfectly with the surroundings while providing comfortable and healthful working conditions for the operators.

The first position of the local switchboard is reserved for rural service and night toll operation. Forty lamp signal rural lines, thirty toll lines, and twenty pay stations, together with the local to rural trunks, make up the incoming line

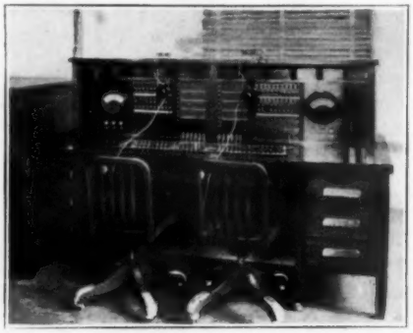
*Clara M. Vasterling, general traffic supervisor of the Southeast Missouri Telo. Co., Cape Girardeau, Mo., handles all matters pertaining to traffic for the entire system.*

equipment of this position. A full local line multiple and universal cords with machine ringing greatly facilitate the handling of this mixed traffic, and insure the best possible service at all times.

Positions Nos. 2 to 7 are equipped for high speed local operation. Prompt answers on original and recalls are assured by multiple call distribution and line lamp recall. Quick response by the called party is assured by machine ringing while the reverting tone assures the calling subscriber that his wants have received attention. Keyless listening and a positive busy lock-out insure all communications against interruption. Instantaneous disconnect assures a complete release of all equipment and the renewal of all busy tests at the completion of the conversation. While providing the most rapid and most popular service from the subscriber's standpoint, these features, by the elimination of many physical and mental functions, abolish operator fatigue and greatly reduce traffic costs.

These additional positions are in place in anticipation of increased business. At the present time these sections are not equipped nor required to handle the 2,300 local lines.

The toll board is located in the same room with the local equipment. This equipment is also modern in every respect and is designed for service and efficiency. Four positions are equipped with a com-



*Two-position Kellogg test board and wire chief's desk recently installed by Southeast Missouri Telo. Co., Cape Girardeau, Mo.*

plete local multiple within reach of each operator. Calculagraphs alternate between each two positions, and rate and route information is held under full width glass bulletin holders in the key-shelf of each position.

A two position information and chief operator's desk is equipped with all modern devices for these classes of service. Complete service observing and monitoring facilities are included. Peg count meters are mounted in the face of the turret and operate automatically from the local cords. In this way the chief operator is at all times advised of the load carried by each position.

All matters pertaining to traffic are un-

*Two-position chief operator's desk now in use by the Southeast Missouri Telo. Co., Cape Girardeau, Mo.*

der the competent supervision of Miss Clara Vasterling, General Traffic Supervisor for the entire system. Miss Vasterling's office is located on the second floor and capably managed by her two assistants during her frequent trips to other parts of the territory.

The mechanical operation of all central office equipment is in charge of Equipment Engineer, Joseph Burciaga. Wire Chief Alvin M. Kempe has direct control of the maintenance of the Cape Girardeau switchboard and apparatus. Mr. Kempe's desk is located conveniently in the main apparatus room on the first floor.

The arrangement of apparatus in this room is ideal from an installing and operating standpoint. With all equipment and iron work finished in gleaming aluminum and generously lighted by windows, a more pleasing appearance would be hard to imagine. Outside cables, from the underground vault, enter through the floor at the base of the main frame. Other cables are laid with exactness on overhead racks to the point where they enter the ceiling on their way to the switchboards.

Power wiring is mainly in conduits laid in the floor and is visible only where it comes to the big ebony asbestos power panel and other equipment. The storage batteries are located in a well ventilated battery room in the basement.

With the exception of the long lines apparatus, practically all central office equipment was furnished by the Kellogg Switchboard & Supply Company of Chicago.


**UNIQUE FURNACE**

**GASOLINE—KEROSENE**

PATENTED ARRANGEMENT FOR DISLODGING COIL WITHOUT TEARING DOWN FURNACE
PATENTED SEAMLESS TUBING COIL GENERATOR
IMPROVED ONE PIECE BURNER
HAND HOLD FOR CLEANER ONE TURN CLEANS ORIFICE
AUTOMATIC ORIFICE CLEANER
AUTOMATIC PUMP INSIDE TANK
15 GUAGE STEEL TANK WELDED BOTTOM

**10 MINUTES TO MELT 50 lbs. OF SOLDER**

But—more important—

The experienced cable splicer will be surprised at the length of time it will remain in the field without attention!

Literature?

**UNIQUE MANUFACTURING CO., Inc**
**221 Whiting St. Chicago, Ill.**

# 7 suits of armor

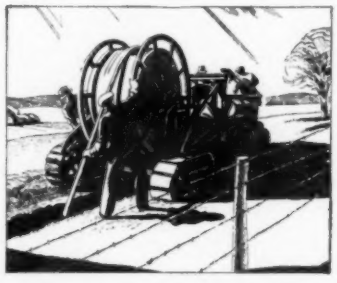
## . . . *Super protection for telephone cable*

7 "suits of armor" . . . 7 separate protective coatings . . . insure long life for the new Western Electric Tape-Armored Telephone Cable.

Layers of impregnated paper, jute, steel tape and asphalt placed over the lead sheath combine to resist earth-corrosion and mechanical damage. In fact these coatings provide the cable with its own protection when laid underground; effecting a saving in laying time and cost; requiring manholes only at loading points.

This cable is backed by the experience and resources of Western Electric, and made to the high engineering standards which that name suggests.

Further information regarding this tape-armored cable will surely be of interest to you. For the facts, write the distributors, Graybar Electric Company who have branch offices in 76 principal cities.



*Laying Western Electric Tape-Armored Cable directly in the ground.*

**Western Electric**

LEAD COVERED CABLE AND TELEPHONE APPARATUS

*Distributed by*

GRAYBAR ELECTRIC CO.

GRAYBAR BUILDING, NEW YORK, N. Y., *Offices in 76 Principal Cities*

# With Manufacturers and Jobbers

## TELKOR MOVES INTO NEW QUARTERS

Telkor, Inc., of Elyria, Ohio, which name is doubtless familiar to the entire telephone industry through one of their products called Telering, the frequency changer or ringing machine which converts commercial alternating current to telephone ringing current, has recently moved into its new quarters shown in the accompanying photograph. This building was formerly a school house and has been entirely remodeled, a new heating plant has been installed together with new and modern plumbing.

This building has sufficient space to accommodate from 150 to 200 employes, and the rooms are large with plenty of good light and ventilation. The grounds surrounding it have been partially landscaped, but this work will be completed in the spring. The location is in a semi-residential district, which adds to the attractiveness of the premises.

*New quarters for Telkor, Inc., at Elyria, Ohio.*

This company was organized in August, 1929, and the progress it has made in so short a period is remarkable. It was organized for the purpose of developing devices which are exclusive and have good patentability and a wide market. So far it has two items on the market, one being Telering, which is so widely known, and the other called the Telkor armor cutter, which is a tool for severing the armor of flexible metallic electrical cable. This tool is used mainly by electrical contractors, and has met with general approval. The company has several other items that it expects to introduce in the near future, and its development laboratory is well equipped for this purpose.

As an index of the fine reception Telering has been given in the industry, it is interesting to learn that these machines are in use in practically every state of the union, a number of provinces in Canada, Newfoundland, Switzerland, Italy, Brazil, Colombia, Mexico, New Zealand, Australia, Philippine Islands, and Hawaii. Also by railroads, power, and pipe line companies, and by the U. S. War Department. This world-wide distribution in so short a time cannot be ignored as practical proof of the satisfactory performance of this machine.

The principle on which Telering operates is entirely new and is one of those things which for years had been declared to be impossible.

This machine reduces the frequency of commercial alternating current of either 60 cycles or 50 cycles to 20 or 16⅔ cycles respectively. The manner of applying this principle in Telering has stimulated a great deal of interest in scientific circles because the vibrating reed which accomplishes this result must control an electrical contact which remains closed for only 1/120 of a second at a time, making and breaking at zero potential. But, in spite of the high speed and accurate movement of this reed, the machine is of rugged construction and more or less free from maintenance difficulties.

The officials and directors of Telkor, Inc., are: Thomas N. Cook, president and treasurer; Fred J. Heavens, vice-president and sales manager; William C. Roe, vice-president and chief engineer; H. W. Ingersoll, secretary; A. J. Curren, president of the Elyria Telephone Company.

The distribution of Telering is in the hands of the leading telephone manufacturers, and it is predicted that this concern will soon become one of the leading industries of its home town, Elyria, Ohio, which, by the way, is of considerable importance as a manufacturing center.

## STROMBERG-CARLSON EQUIPMENT IN WASHINGTON EXCHANGE

The Island Empire Telephone Company of Gig Harbor, Washington, has just contracted with the Stromberg-Carlson Telephone Manufacturing Company for a two position Junior Multiple Switchboard. The switchboard will be equipped with 60 central energy and 50 rural lines and will be complete with power, terminal and machine equipment.

## NEW ELECTRICAL DEVICE IS CORDLESS SOLDERING IRON

A new electrical device which should find special favor with telephone men and in laboratories where soldering operations are not necessarily uniform, is a cordless soldering iron and stand which recently has been placed on the market by the Electric Soldering Iron Co., Inc., of 135 West 17th street, New York City.

*New cordless soldering iron recently placed on market.*

The device may be used in electrical or any kind of soldering, where there is a rest period between the actual soldering operations. Projecting from the handle there is a ring terminal which may be inserted in the socket base in any manner and contact is made. The iron pulls directly out of the stand, and due to an angle in the base, the iron continues in an even arc to the work. However, the iron is disconnected from the circuit when withdrawn, and is therefore limited to soldering within the capacity of the iron.

The iron is especially suitable for work on switchboards or apparatus where the cord is likely to interfere with the work.

Where continuous soldering with a device of this kind is to be done, and a cord is objectionable, two bases and two irons may be used so that one iron is always heating while the other one is in use.

## STROMBERG BOARD

The Kansas Telephone Company of Topeka, Kansas, has just ordered a two-position No. 106 switchboard from the Stromberg-Carlson Telephone Mfg. Co.

The board will consist of 150 central energy and 50 toll and rural lines, and will be complete with power, machine and terminal equipment.

# HEADQUARTERS

FOR TELEPHONE ENGINEERS

*More popular than ever because of the New College Inn, where Ben Bernie appears nightly with his famous Hollywood orchestra*

## HOTEL SHERMAN

RANDOLPH · CLARK · LAKE · LA SALLE · STREETS

## CHICAGO

## Get EVER-PROTECT aid in your construction.

EVER-PROTECT has proved practical and profitable in making many hundreds of cable installations underground without a conduit. It protects cable against storm damage, corrosion, chemical action, electrolysis and abrasion.

In liquid form EVER-PROTECT is great for overhead work, protecting your cable and messengers against chemical action and other destructive influences.

Ask your nearest jobber for complete details.

EVER-PROTECT CABLE COMPOUND
TRADE MARK REG U.S. PAT OFF

National Cable Compound Co.
Incorporated
MITCHELL - - IND.

To Reach the Man Who Does the Buying Advertise in TELEPHONE ENGINEER

HOTEL HARRISON

CHICAGO'S NEWEST DOWNTOWN HOTEL

RUNNING ICE WATER IN EVERY ROOM
$2.50 AND $3.00 WITH BATH NO HIGHER

RADIO IN EVERY ROOM

NO PARKING WORRIES
DIRECT ENTRANCE FROM HOTEL TO HARRISON PARKING GARAGE

HARRISON STREET JUST OFF MICHIGAN BOULEVARD

## CHICAGO

## POSITIONS WANTED

POSITION WANTED: As manager or wire chief of telephone system, either common battery or magneto. Twelve years' experience. Good habits. References. Address P-5, % TELEPHONE ENGINEER, 192 N. Clark St., Chicago.

POSITION WANTED: With small exchange. Twenty-three years' experience in all branches with Independent and Bell Systems. Prefer Neb., Iowa, Minn. or Mo. Address P-6, % TELEPHONE ENGINEER.

POSITION WANTED: As local manager and trouble man of magneto exchange. Can also do construction work. Eight years' experience in magneto plant work. Wife is an operator. Age 27. High school graduate. Best references. Address P-7, % TELEPHONE ENGINEER.

### VACUUM TUBE THEORY AND PRACTICE

(*Continued from page* 40)

as the inherent capacity of the coil windings is generally sufficient to resonate at the desired frequencies.

An approximate idea of the fundamental frequency of an oscillator can be obtained by striking various keys on a piano until one giving a tone similar to the output sound of the oscillator is found. Figure 7 shows the frequency corresponding to different notes on a piano.

**ACCOUNTING**
Specialization on Public Utility Accounting Records and Audits enables us to best serve Telephone Companies.
**HERDRICH AND BOGGS**
Certified Public Accountants
901-7 Continental Bank Bldg., Indianapolis, Ind.

**RECONSTRUCTED EQUIPMENT**

| | |
|---|---|
| Dean or Garford No. 4260 Answering or lamp jacks, per strip of 10 | $ 2.00 |
| Dean, Stromberg or Garford Peanut line and cut-off relays on mounting plates, units of 50 pairs $50.00—units of 60 pairs @ | 60.00 |
| Dean or Garford No. 3210 Multiple jacks, 20 per strip @ | 2.50 |
| Dean or Garford cord Ckt. relays, per pair @ | 1.75 |
| Dean or Garford 4-party push button keys with listening key attached | 1.75 |
| Stromberg No. 53x 3-conductor Swbd. plugs with new cords attached @ | .75 |
| Kellogg No. 28 desk sets with cast head complete with W. E. No. 240 3-bar 1000-1600 or 2500 ohm exposed post signal sets @ | 8.00 |
| Dean Elec. No. 240 4-bar 1000 or 1600 ohm Bdg. compacts with Kellogg Transmitters @ | 7.00 |
| Kellogg No. 2696 type 4-bar 1600 ohm Bdg. compacts @ | 8.50 |
| Western Electric No. 293 Straight line C. B. Wood hotel sets, black finish @ | 6.50 |
| Western Elec. No. 294 Straight line C. B. Short backboard type wall sets | 4.50 |
| Gray 5c single slot type desk or wall type pay stations @ | 1.25 |
| Western Elec. No. 317 3-bar 1000 or 1600 ohm Bdg. compacts @ | 8.75 |
| Western Elec. No. 22 3-bar Bdg. Generators with cranks @ | 1.60 |
| Kellogg No. 97 C. B. Straight line desk sets with steel signal sets @ | 7.00 |

Write for Bulletins
**REBUILT ELECTRIC EQUIPMENT CO.**
1940 West 21st Str., Pilsen Station
Chicago, Ill.

### MINNESOTA TELEPHONE MEN CONVENE

(*Continued from page* 44)

tendent, Lincoln Telephone & Telegraph Company, who discussed "Plant Influence on Service Sales;" Frank B. Randall, general counsel, Northwestern Bell Telephone Company, Omaha, Neb.; J. C. Crowley, Jr., of St. Paul, secretary of the Minnesota association; R. F. Wilder, general superintendent, Tri-State Telephone & Telegraph Company, St. Paul, who spoke of "Some of the Benefits of Cooperation;" H. B. Williams, district manager, Do/More Chair Company, St. Paul; and R. H. Burfeind, sales engineer, Automatic Electric Company, Chicago.

The following directors were elected at the close of the convention: P. M. Ferguson, Mankato; Jay Greaves, Glencoe; A. H. Dreyer, Starbuck; G. M. Owelle, Lake City; H. F. Lueders, Norwood; F. C. Marvin, Zumbrota; Hans Swanson, Warren; S. A. Bask, Blooming Prairie; Irving Todd, Hastings, and E. L. Wright, Alexandria.

S. A. Rask of Blooming Prairie was elected president to succeed Irving Todd. Mr. Rask has been vice-president of the Minnesota association for the past two years. F. C. Marvin of Zumbrota was chosen vice-president; and J. C. Crowley, Jr., of St. Paul, was re-elected secretary-treasurer.

### STROMBERG-CARLSON APPOINTS NEW REPRESENTATIVE

Announcement has just been made that C. W. Watson has been appointed representative for the Stromberg-Carlson Telephone Manufacturing Company in New England.

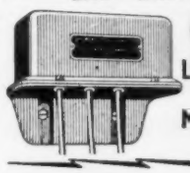
Mr. Watson has been connected with the Stromberg-Carlson Company since 1908 when he became a member of the installation department. In 1922 he was transferred to the sales engineering department. Later he left that department to represent Stromberg-Carlson in Kentucky and Tennessee. He covered this territory until June 15, 1930, at which time he became connected with the Scoville Mercantile Company, Stromberg-Carlson representatives at Atlanta, Ga. He was with this company up to the time he took over his new territory.

Mr. Watson's terrirtory now includes eastern New York and a portion of New England.

FOR SALE: 25 strips Stromberg No. 11-A combined drops and jacks, $8.75 per strip of five. Excellent condition. Corwin Electric Co., Indianapolis, Ind.

FOR SALE: Reliable Electric main distributing frame, capacity line side 500 pairs, switchboard side 400 pairs, equipped with 18 26 pair terminal blocks and 250 pair carbon blocks and fuse protection, price $150.00. Corwin Electric Co., Indianapolis, Indiana.

**J. G. WRAY & CO.**
**Telephone Engineers**
Specialists in Appraisals, Rate Surveys, Financial Investigations, Organization and Operation of Telephone Companies
J. G. Wray, Fellow A. I. E. E.
Cyrus G. Hill
Rm. 2130 Bankers Bldg., Chicago



**CHAPMAN**
LIGHTNING ARRESTERS
MADE BY
MINNESOTA ELECTRIC CO.
MINNEAPOLIS, MINN.

We will sell your
**Telephone Directory ADVERTISING**
or will publish your directory complete
**L. M. BERRY & CO.** DAYTON, OHIO

Send for free sample and prices on
**UNIVERSAL DROP WIRE INSULATORS**
Universal Specialty Company
711 Poplar St., Terre Haute, Ind.

**FOR SALE**
KELLOGG COMMON BATTERY EQUIPMENT
Late type Relays, mounted 8-10-16-20 per strip @ $2.50.
Lamp Jacks, single mounting @ 10c.
24 or 48 volt Switchboard Lamps @ 11c.
No. 264 Four-Party Ringing Keys @ $2.60.
We have some odd lots of pole hardware and Cable terminals. Also Telephone Booths with folding doors. Prices and description on request.
**Telephone Repair Shop**
1760 Lunt Ave., Chicago, Ill.

**American Electric Co. Equipment**

| | |
|---|---|
| No. 50 transmitters | $ .75 |
| No. 60 receivers with new shells and caps | .75 |
| New shells and caps | .35 |
| No. 102 or 127 switch hooks | .45 |
| No. 76 ringers | 1.00 |
| ½-MF, 1-MF and 2-MF Mansbridge condensers | .50 |
| 5-C and 31-B induction coils | .50 |
| 3, 4 and 5 bar Hercules late type generators | $2.00, 2.50 and 3.00 |

**Buckeye Telephone & Supply Company**
COLUMBUS, OHIO

# With Manufacturers and Jobbers

## TELKOR MOVES INTO NEW QUARTERS

Telkor, Inc., of Elyria, Ohio, which name is doubtless familiar to the entire telephone industry through one of their products called Telering, the frequency changer or ringing machine which converts commercial alternating current to telephone ringing current, has recently moved into its new quarters shown in the accompanying photograph. This building was formerly a school house and has been entirely remodeled, a new heating plant has been installed together with new and modern plumbing.

This building has sufficient space to accommodate from 150 to 200 employes, and the rooms are large with plenty of good light and ventilation. The grounds surrounding it have been partially landscaped, but this work will be completed in the spring. The location is in a semi-residential district, which adds to the attractiveness of the premises.

*New quarters for Telkor, Inc., at Elyria, Ohio.*

This company was organized in August, 1929, and the progress it has made in so short a period is remarkable. It was organized for the purpose of developing devices which are exclusive and have good patentability and a wide market. So far it has two items on the market, one being Telering, which is so widely known, and the other called the Telkor armor cutter, which is a tool for severing the armor of flexible metallic electrical cable. This tool is used mainly by electrical contractors, and has met with general approval. The company has several other items that it expects to introduce in the near future, and its development laboratory is well equipped for this purpose.

As an index of the fine reception Telering has been given in the industry, it is interesting to learn that these machines are in use in practically every state of the union, a number of provinces in Canada, Newfoundland, Switzerland, Italy, Brazil, Colombia, Mexico, New Zealand, Australia, Philippine Islands, and Hawaii. Also by railroads, power, and pipe line companies, and by the U. S. War Department. This world-wide distribution in so short a time cannot be ignored as practical proof of the satisfactory performance of this machine.

The principle on which Telering operates is entirely new and is one of those things which for years had been declared to be impossible.

This machine reduces the frequency of commercial alternating current of either 60 cycles or 50 cycles to 20 or 16⅔ cycles respectively. The manner of applying this principle in Telering has stimulated a great deal of interest in scientific circles because the vibrating reed which accomplishes this result must control an electrical contact which remains closed for only 1/120 of a second at a time, making and breaking at zero potential. But, in spite of the high speed and accurate movement of this reed, the machine is of rugged construction and more or less free from maintenance difficulties.

The officials and directors of Telkor, Inc., are: Thomas N. Cook, president and treasurer; Fred J. Heavens, vice-president and sales manager; William C. Roe, vice-president and chief engineer; H. W. Ingersoll, secretary; A. J. Curren, president of the Elyria Telephone Company.

The distribution of Telering is in the hands of the leading telephone manufacturers, and it is predicted that this concern will soon become one of the leading industries of its home town, Elyria, Ohio, which, by the way, is of considerable importance as a manufacturing center.

## STROMBERG-CARLSON EQUIPMENT IN WASHINGTON EXCHANGE

The Island Empire Telephone Company of Gig Harbor, Washington, has just contracted with the Stromberg-Carlson Telephone Manufacturing Company for a two position Junior Multiple Switchboard. The switchboard will be equipped with 60 central energy and 50 rural lines and will be complete with power, terminal and machine equipment.

## NEW ELECTRICAL DEVICE IS CORDLESS SOLDERING IRON

A new electrical device which should find special favor with telephone men and in laboratories where soldering operations are not necessarily uniform, is a cordless soldering iron and stand which

*New cordless soldering iron recently placed on market.*

recently has been placed on the market by the Electric Soldering Iron Co., Inc., of 135 West 17th street, New York City.

The device may be used in electrical or any kind of soldering, where there is a rest period between the actual soldering operations. Projecting from the handle there is a ring terminal which may be inserted in the socket base in any manner and contact is made. The iron pulls directly out of the stand, and due to an angle in the base, the iron continues in an even arc to the work. However, the iron is disconnected from the circuit when withdrawn, and is therefore limited to soldering within the capacity of the iron.

The iron is especially suitable for work on switchboards or apparatus where the cord is likely to interfere with the work.

Where continuous soldering with a device of this kind is to be done, and a cord is objectionable, two bases and two irons may be used so that one iron is always heating while the other one is in use.

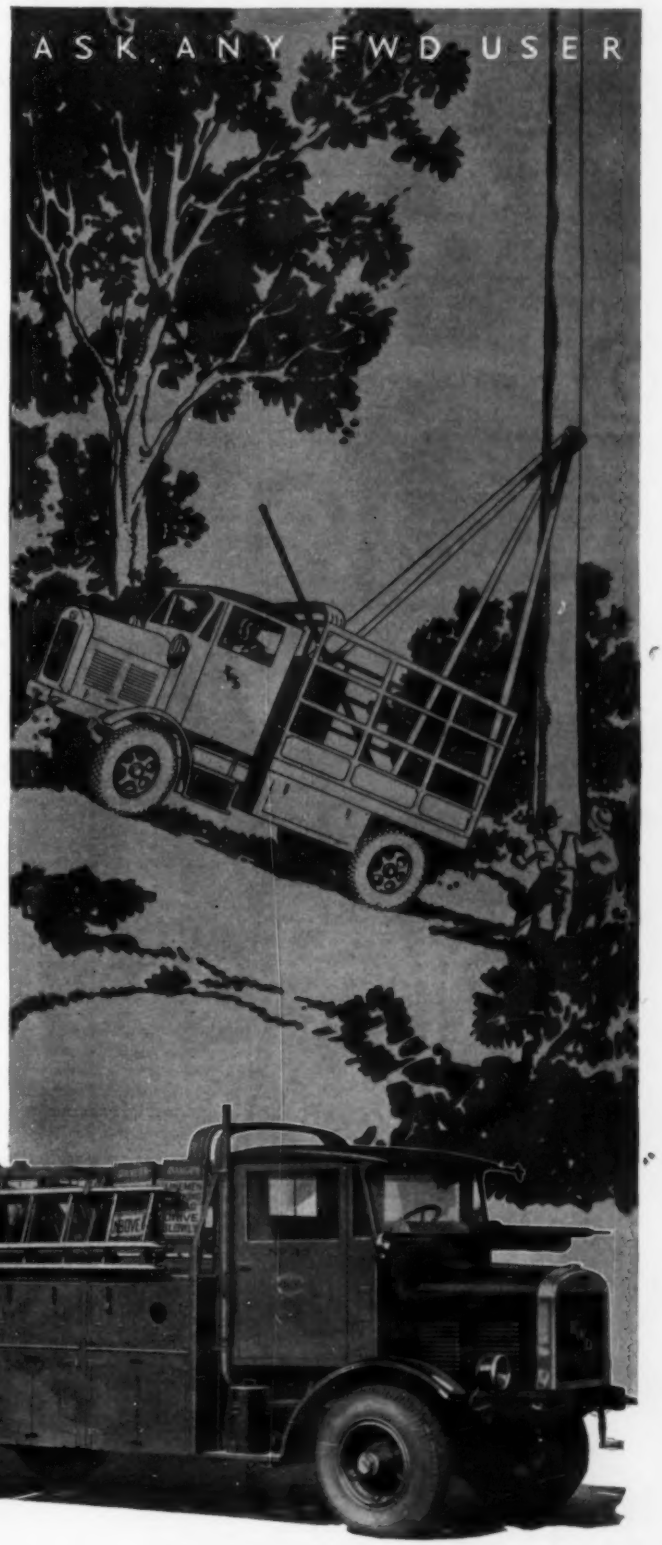
## STROMBERG BOARD

The Kansas Telephone Company of Topeka, Kansas, has just ordered a two-position No. 106 switchboard from the Stromberg-Carlson Telephone Mfg. Co.

The board will consist of 150 central energy and 50 toll and rural lines, and will be complete with power, machine and terminal equipment.

# . . . More than a Truck

## *because every* FWD *wheel is a worker*




FOUR *live* wheels — to grip and pull FWD's through the toughest kind of going, and under *capacity* loads! Four *live* wheels — to speed FWD's over any kind of road swiftly and with real transportation savings! The FWD principle of power and pull on all four wheels gives positive traction.

The FWD truck is different in principle . . . it distributes the power equally to each of the four wheels . . . This principle of propulsion gives the truck greater power . . . not that it develops more power, but it puts all of the power developed to actual use. It does more work at the operating cost of an ordinary truck. Consequently the work is done for less money.

Because of the Four Wheel Drive principle, FWD trucks provide reliable, economical transportation — either for hauling over hard surfaced roads or for heavy duty jobs in mud, sand, or snow. They are ideal for public utility and telephone work . . . for road building and maintenance or pole setting and line work. Their success in this field is shown by the fact that ninety-three public utility companies have already purchased FWD's. And many of these companies have purchased FWD's again and again.

*Let us send you a booklet entitled "FWD Trucks for Utility Service". Write today!*

**THE FOUR WHEEL DRIVE AUTO COMPANY**
**CLINTONVILLE** **WISCONSIN**

**Canadian Factory**
**KITCHENER, ONTARIO**

FWD

BACKED BY NATION-WIDE SERVICE

# TELEPHONE ENGINEER

192 N. Clark St., Chicago. Telephone STAte 8971

PUBLISHED MONTHLY BY

TELEPHONE ENGINEER PUBLISHING COMPANY

J. A. SMITH, 192 N. Clark St., Chicago, President and Treasurer — C. L. JONES, Athens, Ohio, Vice-President

D. WEINER, 192 N. Clark St., Chicago, Secretary — F. A. BOWDLE, Cerro Gordo, Illinois, Vice-President

Vol. 35 No. 3 — HAROLD L. BEYER, Chicago, Vice President — March, 1931

SUBSCRIPTIONS:—The subscription price of TELEPHONE ENGINEER is $2.00 a year in the United States, Cuba and Mexico; in Canada it is $3; in all other countries $4. Single copies, U. S. A., 20 cents.

Entered as second-class matter, June 6, 1922, at the post office at Chicago, Ill., under the act of March 3, 1879


## Table of Contents


Editorials ..... 15-16

Telephone Studies for Beginners—Appeal of Plant Schools and Conferences—Utilities Meet the Depression

Our Engineering and Management Course—by B. C. Burden ..... 17-18-19

Pointers on Proper Substation Installation—by Ray Blain ..... 20-21-54

Relays Involved in Ringing Key Operations—by J. G. Levis ..... 22-40

Vacuum Tube Theory and Practice ..... 23-24

Repeating Coils Minimize Noise Currents—by A. G. Ganz .. 25

Standard Dimension Tables for Wood Poles ..... 26-27

Line and Desk ..... 30-31

Features of Modern Telephone Pay Station—by W. J. Vincent ..... 32-33

The Technical Clearing House—by B. C. Burden ..... 36-40

New Central Office Equipment at Eldon, Iowa ..... 38-40

Value of Publications to the Industry ..... 42

Telo-Mike—What It Is and What It Does ..... 46-53

Telephone Activities Abroad ..... 50

Restores Service in Record Time ..... 48-53

With the Manufacturers and Jobbers ..... 51-52-53


## Index to Advertisers


A

American Cross Arm & Conduit Co. ..... —
American Electric Co., Inc. ..... 8
American Telephone & Telegraph Co. ..... 34-35
Automatic Electric Co. ..... 28-29
Automatic Tel. Mfg. Ltd. ..... —
Acorn Insulated Wire Co. ..... 56

B

Berry, L. M. ..... 54
Bernz Co., Otto ..... —
Blake Signal & Mfg. Co. ..... 11
Block, Lynton T., & Co. ..... —
Bond Electric Corp. ..... 53
Bowdle Accounting System ..... —
Brown, W. P., & Sons Lbr. Co. ..... 39
Buckeye Telephone & Supply Co. ..... 54

C

Calculagraph Co. ..... 37
Carolina Wood Preserving Co. ..... —
Cook Electric Co. ..... 14
T. J. Cope, Inc. ..... 11
Curtin-Howe Corp. ..... 1
B. J. Carney & Co. ..... 41

E

Electric Storage Battery Co. ..... 10

F

Forged Steel Products Co. ..... 43
Four Wheel Drive Co. ..... 9
Ft. Dearborn Hotel ..... —
French Battery Co. ..... 47

G

Graybar Electric Co. ..... 37-43

H

Harrison Hotel ..... 45
Herdrich & Boggs ..... 54
Holtzer-Cabot Electric Co. ..... —

I

Indiana Steel & Wire Co. ..... 47
Ind. Sales & Eng. Co. ..... 13

K

Kaul Clay Mfg. Co. ..... —
Kearney Corp., Jas. R. ..... 2
Kellogg Switchboard & Supply Co. ..... 4-5
Kester Solder Co. ..... —

L

Lorraine Hotel ..... 45

M

MacGillis & Gibbs Co., The ..... 41
Master Plier Corp. ..... —
W. N. Matthews Corp. ..... —
Michigan Pole & Tie Co. ..... 10
Minerallac Electric Co. ..... 1
Minnesota Electric Co. ..... 54

N

National Cable Compound Co. ..... 45
National Carbon Co. ..... 45
National Fireproofing Co. ..... —
National Lumber & Creosoting Co. ..... —
Naugle Pole & Tie Co. ..... 41
Northern White Cedar Ass'n ..... 49

P

Partridge, T. M., Co. ..... 41
Phillips, Eugene F., Electrical Works, Ltd. ..... 13

R

Rebuilt Electric Equipment Co. ..... 54
Reliable Electric Co. ..... 3
Runzel-Lenz Elec. Mfg. Co. ..... 11

S

Sands Electric Co. ..... 1
Sherman Hotel ..... 45
Signal Eng. & Mfg. Co. ..... —
Stewart Bros. ..... 11
Standard Appliance Co. ..... 47
Stromberg-Carlson Tel. Mfg. Co. ..... 6-7-55
Suttle Equipment Co. ..... 12

T

Telephone Repair Shop ..... 54
Teletype Corporation ..... —
Telkor, Inc. ..... 37
Templeton-Kenly Co. ..... 41
Texas Creosoting Co. ..... —

U

Universal Specialty Co. ..... 54
Unique Mfg. Co. ..... 53

W

Welker, J. H. ..... 54
Western Electric ..... —
J. G. Wray & Co. ..... 54
P. Wall Mfg. Supply Co. ..... 1
Waterbury Battery Co. ..... 11



*dependable*

**NORTHERN WHITE CEDAR POLES**

that offer *utmost* in Quality and Value.

*Guaranteed* Butt Treatments

**MICHIGAN POLE & TIE CO.**

NORTHERN AND WESTERN POLES

NEWBERRY, MICHIGAN

Reed City, Mich. YARDS St. Paul, Minn.

**For Every Job**

Dependable battery operation is imperative to uninterrupted telephone service.

Exides are dependable. Thirty-five years of service in the telephone industry have proven that. Dependable Exides assure a long life of satisfactory service.

**DEPENDABLE EXIDE BATTERIES**

Exide BATTERIES

The Electric Storage Battery Company

Philadelphia Penna.